



**US Army Corps
of Engineers**
Mississippi River
Commission

DTIC FILE COPY

(4)

AD-A196 342

A PHYSICAL DESCRIPTION OF MAIN STEM LEVEE BORROW PITS ALONG THE LOWER MISSISSIPPI RIVER

DTIC

JUN 15 1988

LOWER MISSISSIPPI RIVER ENVIRONMENTAL PROGRAM
REPORT 2

FEBRUARY 1988



PREPARED FOR: PRESIDENT, MISSISSIPPI RIVER COMMISSION
PO BOX 80
VICKSBURG, MISSISSIPPI 39180-0080

DISTRIBUTION STATEMENT A

Approved for public release
Distribution Unlimited

88 6 14 051

Destroy this report when no longer needed. Do not return
it to the originator.

The findings in this report are not to be construed as an official
Department of the Army position unless so designated
by other authorized documents.

The contents of this report are not to be used for
advertising, publication, or promotional purposes.
Citation of trade names does not constitute an
official endorsement or approval of the use of
such commercial products.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE				Form Approved OMB No 0704-0188 Exp Date Jun 30, 1986	
1a REPORT SECURITY CLASSIFICATION Unclassified			1b RESTRICTIVE MARKINGS		
2a SECURITY CLASSIFICATION AUTHORITY			3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.		
2b DECLASSIFICATION/DOWNGRADING SCHEDULE					
4 PERFORMING ORGANIZATION REPORT NUMBER(S) Lower Mississippi River Environmental Program, Report 2			5 MONITORING ORGANIZATION REPORT NUMBER(S)		
6a NAME OF PERFORMING ORGANIZATION President, Mississippi River Commission		6b OFFICE SYMBOL (If applicable)		7a NAME OF MONITORING ORGANIZATION	
6c ADDRESS (City, State, and ZIP Code) PO Box 80 Vicksburg, MS 39180-0080			7b ADDRESS (City, State, and ZIP Code)		
8a NAME OF FUNDING/SPONSORING ORGANIZATION President, Mississippi River Commission		8b OFFICE SYMBOL (If applicable)		9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c ADDRESS (City, State, and ZIP Code) PO Box 80 Vicksburg, MS 39180-0080			10 SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO	PROJECT NO	TASK NO
			WORK UNIT ACCESSION NO		
11 TITLE (Include Security Classification) A Physical Description of Main Stem Levee Borrow Pits Along the Lower Mississippi River; Lower Mississippi River Environmental Program, Report 2.					
12 PERSONAL AUTHOR(S) Buglewicz, Eugene G.; Mitchell, Wilma A.; Scott, Jerry E.; Smith, Maryetta; and King, Wendell L.					
13a TYPE OF REPORT Final report		13b TIME COVERED FROM _____ TO _____		14 DATE OF REPORT (Year, Month, Day) February 1988	
				15 PAGE COUNT 205	
16 SUPPLEMENTARY NOTATION Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22151.					
17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
			Levee borrow pit Physical descriptions		
			Mississippi River Sediment		
			Morphology Water quality		
19 ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>Twenty-five borrow pits along the main stem levee system of the Lower Mississippi River were investigated with regard to selected physical, chemical, and biological resources as part of the Lower Mississippi River Environmental Program. Objectives of the levee borrow pit investigation are to develop an inventory of environmental resources of the borrow pits and to develop environmental design criteria for borrow pits to be used during levee construction. The 25 borrow pits were located between the levees along the Mississippi River from near New Madrid, Missouri (River Mile (RM) 877) to near Belmont, Louisiana (RM 151).</p> <p>Data on fishes, water quality, macrobenthos, and sediments were collected during the summer of 1981. A topographic field survey of each borrow pit was conducted during 1982. A vegetation survey was conducted from 1981 to 1983 as part of a companion study of bird and mammal use. <u>Vegetation data are summarized in this report.</u></p>					
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			21 ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a NAME OF RESPONSIBLE INDIVIDUAL			22b TELEPHONE (Include Area Code)		22c OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted
All other editions are obsoleteSECURITY CLASSIFICATION OF THIS PAGE
Unclassified

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

19. ABSTRACT (Continued).

Levee borrow pits range in size from one acre ponds to lakes of 50 or more acres. Traditional indicators of environmental quality based on morphological characteristics do not generally fit these unique aquatic basins. The borrow pit basins are generally shallow with most of the bottom in the photic zone. Physico-chemical indicators suggest a productive aquatic habitat.

Although the data are survey in scope, it represents the first time a large number of borrow pits representing the entire Lower Mississippi River have been described and compared.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

PREFACE

The Lower Mississippi River Environmental Program (LMREP) is being conducted by the Mississippi River Commission (MRC), US Army Corps of Engineers. It is a comprehensive program of environmental studies of the leveed floodplain of the Lower Mississippi River and features of the main stem Mississippi River and Tributaries (MR&T) Project. The purposes of the program are to develop environmental inventory data and environmental design considerations for the navigation and flood control features of the MR&T.

One component on the LMREP is the Levee Borrow Pit Investigation (LBPI). This report documents the results of topographic surveys and selected physical, chemical, and biological investigations of main stem levee borrow pits, one work unit of the LBPI. Included is information on the morphology of levee borrow pits, water and sediment analysis as well as physical descriptions of individual borrow pit features.

This report was prepared by Mr. Eugene G. Buglewicz, MRC; Dr. Wilma A. Mitchell, US Army Engineer Waterways Experiment Station (WES); and Mr. Jerry E. Scott, Ms. Maryetta Smith, and Mr. Wendell L. King, US Army Engineer District, Vicksburg (VXD).

Topographic surveys and hydrologic studies were carried out by VXD. Biological, sediment and water quality data were collected by WES.

The investigation was managed by the Planning Divisions of the MRC and the VXD and was sponsored by the Engineering Division, LMVD. Mr. Scott was the study manager for the borrow pit investigation; Mr. Cobb was the program manager for the LMREP. The investigation was conducted under the direction of the President of the Mississippi River Commission, Major General William E. Read, now retired, and Major General Thomas A. Sands.

Approved For	
NDS - CRA21	<input checked="" type="checkbox"/>
DDO - JAB	<input type="checkbox"/>
Unlimited Ref	<input type="checkbox"/>
Distribution	
by	
Unlimited	
Date of Review	
DDO	
A-1	

CONTENTS

	<u>Page</u>
PREFACE	1
CONVERSION FACTORS, NON-SI TO SI METRIC UNITS OF MEASUREMENT.....	4
PART I: INTRODUCTION	5
Background.....	5
Mississippi River & Tributaries (MR&T) Project.....	5
Lower Mississippi River Environmental Program (LMREP).....	5
Environmental Setting, Lower Mississippi River.....	6
Purpose and Scope.....	9
Levee Borrow Pits.....	10
History of Borrow Pit Construction.....	10
Current Construction Methods.....	14
PART II: METHODS AND MATERIALS.....	16
Selection of Borrow Pits for Field Sampling.....	16
Field Data Collection.....	16
Physical Characteristics.....	18
Laboratory Analysis.....	21
PART III: RESULTS.....	22
Physical Description of Study Borrow Pits.....	22
Surface Area.....	22
Shoreline Length.....	22
Shoreline Development Index.....	23
Subsurface Dimensions.....	25
Maximum and Mean Depths.....	25
Volume.....	25
Indices to Basin Shape.....	28
Volume Development Index.....	28
Mean Basin Slope.....	30
Sediment.....	30
Volatile Residue.....	31
Flooding.....	31
Water Quality and Sediment.....	33
PART IV: DISCUSSION.....	42
PART V: CONCLUSIONS.....	44
REFERENCES.....	45

	<u>Page</u>
TABLES 1-8.....	47
APPENDIX A: BORROW PIT PHYSICAL CHARACTERIZATION DATA	A1
APPENDIX B: SCIENTIFIC AND COMMON NAMES OF PLANTS AND THEIR PRESENCE/ABSENCE AT BORROW PITS ALONG THE LOWER MISSISSIPPI RIVER... ..	B1
APPENDIX C: CONTOUR MAPS OF BORROW PITS ALONG THE LOWER MISSISSIPPI RIVER.....	C1

CONVERSION FACTORS, NON-SI TO SI METRIC
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
acres	4,046.873	square metres
cubic feet	0.02831685	cubic metres
cubic yards	0.7645549	cubic metres
fahrenheit degrees	*	celsius degrees or kelvins
feet	0.3048	metres
inches	2.54	centimetres
miles (US statute)	1.609347	kilometres
pounds per acre	0.4535924	kilograms

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9) (F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9) (F - 32) + 273.15$.

LOWER MISSISSIPPI RIVER ENVIRONMENTAL PROGRAM

A Physical Description of Main Stem Levee Borrow Pits Along the Lower Mississippi River

PART I: INTRODUCTION

Background

Mississippi River & Tributaries (MR&T) Project

1. Seasonal flooding has been a hinderance to the settlement and development along the Lower Mississippi River for over 200 years. The first attempt to control destructive flooding occurred at New Orleans where a low levee was constructed in 1727. As settlement expanded throughout the floodplain, levee systems were constructed based solely on local experience (Jackson 1931). Levee failures were common. The Mississippi River Commission (MRC) was established by Congress in 1879 to carry out flood control efforts on the lower river. The devastating 1927 Mississippi River flood resulted in the passage of the Flood Control Act of 1928 which authorized the Mississippi River and Tributaries (MR&T) Project. The MR&T Project is carried out by the MRC. It is a comprehensive plan for both flood control and navigation improvements on the Lower Mississippi River and tributaries.

Lower Mississippi River Environmental Program (LMREP)

2. The LMREP is a 7-year research program with the dual objectives of developing baseline environmental resource data on the Lower Mississippi River and associated leveed floodplain, and formulating environmental design considerations for the main stem levee system and channel improvement works. The LMREP was initiated in fiscal year 1981 and is scheduled for completion in fiscal year 1988. The LMREP is composed of five work units: levee borrow pit investigations, dike system investigations, revetment investigations, habitat inventories, and development of environmental design considerations for levees, dikes, and revetment features of the MR&T Project.

3. The Levee Borrow Pit Investigation (LBPI) was initiated in 1981 and includes detailed fish, benthos, sediment and water quality data collection, and field surveys to describe the physical characteristics and terrestrial and aquatic wildlife use of 25 selected borrow pits located the length of the Lower Mississippi River. Specific objectives of the LBPI are:

- a. To develop an inventory of fish and wildlife resources of main stem levee system borrow pits.
- b. To formulate environmental design considerations for main stem levee system borrow pits.

4. Data acquisition. Fish and aquatic sampling was conducted by the US Army Engineer Waterways Experiment Station (WES) from June through August 1981. Topographic field surveys were conducted during 1982 and 1983 by the US Army Engineer District, Vicksburg (VXD). Wildlife surveys were conducted by WES from December 1981 through 1983. This report presents the results of morphologic studies of levee borrow pits and other physical characteristics analyzed as part of the LBPI.

Environmental setting.
Lower Mississippi River

5. Physical description. The Lower Mississippi River is located in the Central Gulf Coastal Plain. The river and its tributaries form the largest river system in North America in terms of length and volume of flow. The Mississippi River drains all or parts of 31 states and two Canadian provinces and supports a drainage basin of 1,245,000 square miles*, or 41 percent of the land area in the contiguous United States. The Lower Mississippi River flows through an alluvial valley which encompasses 35,000 square miles and averages 45 miles in width. Mean annual discharge is 552,000 cubic feet per second (cfs) at Vicksburg, Mississippi. A maximum confined discharge of 2,060,000 cfs was recorded at Vicksburg on 17 February 1937. Had the levees held during the massive 1927 flood, the maximum discharge passing Vicksburg would have totaled 2,278,000 cfs. A minimum discharge of 93,800 cfs occurred on 31 August 1936. Major tributaries to the Lower Mississippi River includes: the

* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

Ohio River below Cairo, Illinois; the St. Francis, Arkansas-White Rivers in Arkansas; the Obion and Hatchie Rivers in Tennessee; and the Yazoo, Big Black and Homochitto Rivers in Mississippi.

6. The Lower Mississippi River falls from an elevation of approximately 300 feet National Geodetic Vertical Datum (NGVD) at Cairo, to sea level, a distance of approximately 955 river miles. The pervasive river flow is estimated to transport 136 million tons of dissolved matter and 161 million tons of suspended material annually to the Gulf of Mexico.

7. The climate of the study area varies from humid subtropical along the Gulf Coast to humid and continental at Cairo. Precipitation ranges from approximately 64 inches annually on the Louisiana coast to 45 inches at Cairo, Illinois. Average annual temperatures range from 60°F to 70°F North to South, with January temperatures averaging 40°F in the North and 55°F in the South. Summer high temperatures are similar, with July temperatures averaging 80°F in the North and 82°F in the South.

8. The main stem levee system which includes levees, floodwalls, control structures and floodways, constitutes an integrated flood control system 2,202.1 miles long. For purposes of the LMREP, the mainline levees, which parallel the Lower Mississippi River for 1,608.3 miles, form an important ecological controlling feature and delineate the east and west boundaries of the study area (Figure 1).

9. The levee line on the west bank begins south of Cape Girardeau, Missouri and extends approximately 310 levee miles to the north bank of the St. Francis River at RM 672. The levee begins again at Helena, Arkansas at RM 666 and extends another 70 miles to RM 605 where the Arkansas-White Rivers meet the Mississippi River. The levee then continues unbroken from RM 605 south of the Arkansas River to Venice, Louisiana, a distance of approximately 650 levee miles.

10. The levee line on the east bank is composed of five segments which alternate with high bluffs to provide flood protection. The first segment extends from Hickman, Kentucky near RM 922 approximately 32.5 miles to Kentucky Point at RM 892. The second segment begins near Tiptonville, Tennessee at RM 735 and runs approximately 35 levee miles to the Obion River at RM 820. At Memphis, Tennessee near RM 735, the levee extends southward in the longest east bank segment to just north of

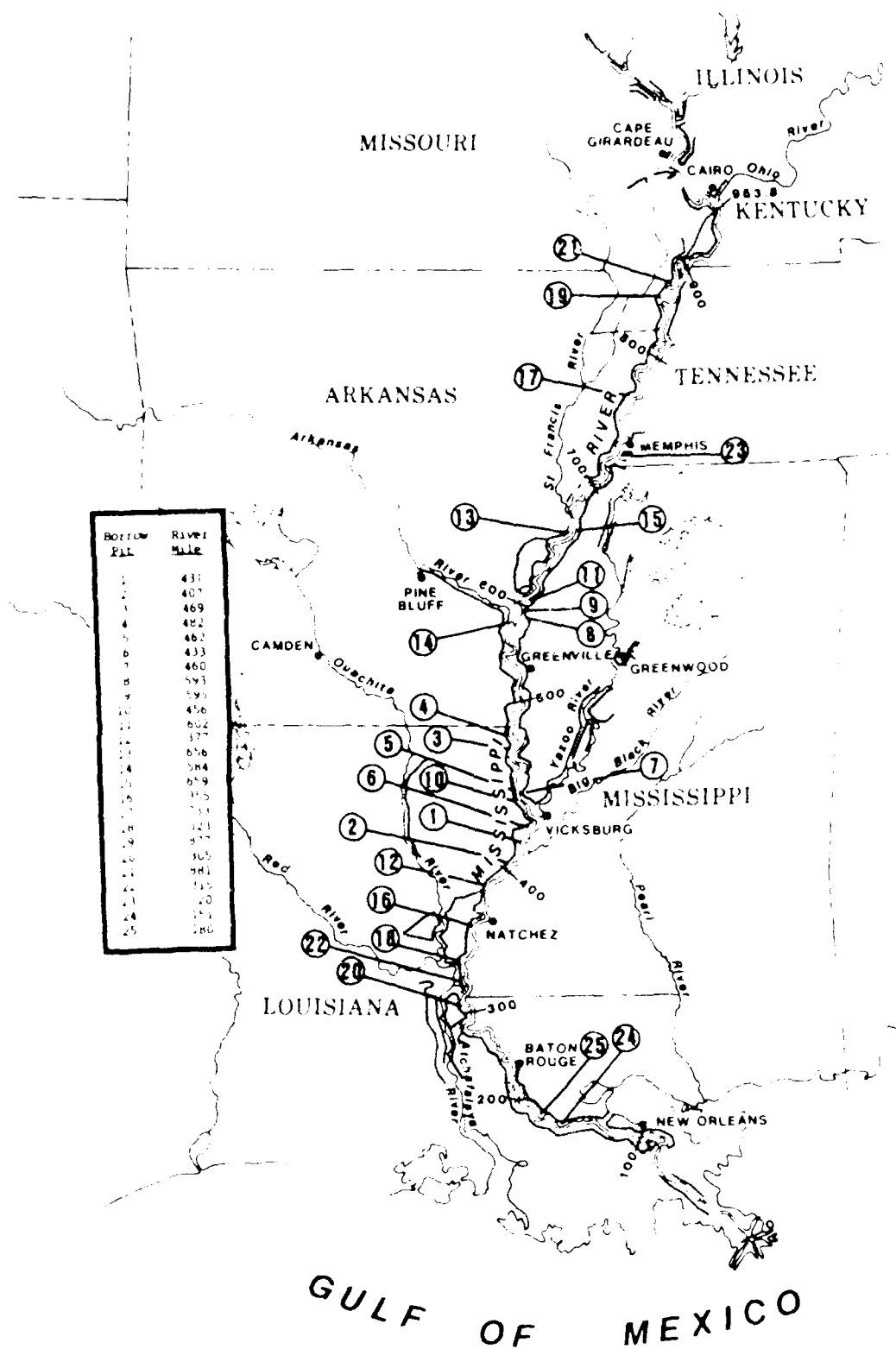


Figure 1. Flood control levees and location of borrow pits studied during 1980 and 1981

Vicksburg, Mississippi near RM 437. From this point until Baton Rouge, Louisiana at RM 230, high bluffs generally constitute the extent of the floodplain, although local levees may protect isolated floodplain lands used for various purposes, mainly agriculture. From Baton Rouge, Louisiana, the levee extends to RM 44.9 near Point A La Hache, Louisiana. South of Point A La Hache, the final levee section begins at Bayou Lamoque, Louisiana (RM 33) and extends to RM 11.5 near Head of Passes.

11. The levee system encloses an interrelated complex of floodplain aquatic and terrestrial habitats influenced by the hydrological cycle of the Mississippi River. The spatial distribution of these habitats reflects the interplay of fluvial processes that mold the floodplain landscape. The most comprehensive environmental description of the Lower Mississippi River to date was prepared for LMVD by Ryckman, Edgerley, Tomlinson and Associates (1975) in which six terrestrial communities and five aquatic habitats were described. Cobb and Clark (1981) described 12 aquatic habitats for a 50-mile reach of the Lower Mississippi River. In both reports, borrow pits were identified as specific habitat types.

Purpose and scope

12. The levee borrow pits provide a potentially valuable sport and commercial fishery resource along the Mississippi River. Cobb et al. (1984), reported an average yield of 44 pounds/acre of sport fish and 354 pounds/acre of commercial fish from the levee borrow pits. The full sport and commercial potential of the borrow pits is somewhat restricted due to private ownership of the borrow pits and limited access to the levee system.

13. The function of borrow pits to total Mississippi River ecology is unknown. Borrow pits provide slack water in the floodplain during within-bank river flows, and this intuitively adds to overall aquatic habitat diversity.

14. The purpose of this report is to summarize the physical characteristics of borrow pits located on the floodplain between the mainline levees of the Lower Mississippi River.

15. Companion reports discuss the results of the aquatic and terrestrial biological investigations, and relate these results to borrow pit physical characteristics described in this report.

Levee Borrow Pits

16. The extraction of borrow or soil material is a common construction practice which results in an excavation called a borrow pit. The levee system of the Lower Mississippi River Valley has been constructed of material removed from borrow pits lying generally parallel and adjacent to the levee embankment. Levee and borrow pit construction began with efforts to protect early settlers from Mississippi floodwaters and has continued to the present. Construction methods have progressed from the use of shovels and wheelbarrows for building the first low levees to the manipulation of modern, highly mechanized heavy equipment for enlarging existing levees (Figures 2 and 3). Likewise, standard borrow pit specifications have evolved with the expansion and development of the mainline levee system.

History of Borrow Pit Construction

17. Documentation of early borrow pit construction is limited. An 1848 Mississippi Law provides instructions for levee construction and specifies the correct placement of borrow areas (Harrison 1950). Earth was to be taken from the riverside of the levee at a distance which would allow 3 feet of space between the borrow pit and levee base. The pits were not to run parallel to nor come within 10 feet of levees that exceeded 4 feet in height. In the book Principles and Practice of Embanking Lands from River-Floods, Hewson (1860) recommended the following practices: (a) locate the pit at least 10 feet from the berm; (b) leave earthen walls between the pits to accelerate flood deposition of sediment and prevent scour on the embankment; and (c) construct the inner slope of the pit at an angle equal to that of the adjoining levee slope.

18. Early levees were constructed by local landowners or governmental units with little or no levee construction experience or appreciation for the interdependence of adjoining levee projects. These low levees were generally unsuccessful in controlling flooding, thus agriculture in the fertile floodplain was totally dependent on river stage. The creation of the Mississippi River Commission in 1879, however, placed the problem of levee construction on a coordinated and progressive basis.



Figure 2. Early levee construction methods. Note location of borrow pits in relation to levee, and use of traverses



Figure 3. Modern equipment constructing levees along
the Lower Mississippi River

19. Levee borrow pits were located on either the landside or riverside of the levee, wherever materials could be most efficiently and economically secured. However, frequent use of landside borrow pits in early levee construction often led to foundation seepage. As development of the floodplain increased with the extension of the levee system, seepage became a major concern and borrow pit specifications were developed to minimize the danger of levee failure (Jackson 1931). Borrow pits were located on the riverside of the levee wherever possible, and a berm 20 to 40 feet wide was constructed between the toe of the levee slope and the inner lip of the pit. The borrow pit was dug wide and shallow to avoid exposing pervious material, and the bottom was sloped away from the levee at a grade usually no steeper than 1 on 25.

20. Differences in borrow pit construction specifications resulted from differences in subsoil conditions, and varied with location along the river (Elliott 1932). Subsoils found above the mouth of the Red River are much less satisfactory for levee foundations than those found below Red River. Standard specifications for levees above Red River called for a berm of 40 feet and a pit bottom slope of 1 on 50. Below Red River, a 40-foot berm was also required, but the bottom slope could be as steep as 1 on 10. Above the Missouri River the berm was usually about 20 feet wide, and the pits somewhat deeper than on the lower river.

21. Traverses were left in place at intervals across the borrow pits. These unexcavated zones were 14 feet wide at the top with side slopes of 1 on 2. Traverses were usually breached to permit drainage between contiguous pits (Elliott 1932). Traverses provided roadways across the borrow pits, prevented current wash on the levee embankment, and encouraged sediment deposition during high water stages.

22. Drainage of borrow pits was a common practice where the owner of the borrow pit intended to convert the sump area to agricultural uses. Near population centers borrow pits were drained for mosquito control. Drainage structures were provided for other borrow pits to decrease hydrostatic pressure, or reduce sloughing behind caving or revetted banks (US Army Corps of Engineers, Mississippi River Commission 1947).

Current Construction Methods

23. Standard practices for borrow pit construction have developed with improvement in levee design. Minimum pit specifications are contained in each contract and are based on soil characteristics and availability of construction materials in the project right-of-way. Soil borings detect the most suitable soils for borrow acquisition, but accessibility and proximity are often the controlling factors in site selection. Generally, the most economical scheme is to establish long, shallow pits parallel and adjacent to the levee alignment (Department of the Army, Corps of Engineers 1978).

24. Borrow pits are located on the riverside of the levee unless suitable material is unavailable. Borrow pits may extend to within 50 feet of the river if excavated in impervious soil. Borrow pits are placed a minimum of 40 feet from the toe of the levee or stability berm. The leveeward slope of the pit walls is no greater than 1 on 2, and the maximum slope of the pit riverward is 1 on 25.

25. The depth of excavation is variable and determined by borings so that from 2 to 5 feet of impervious cover soil, usually clay, will remain to prevent seepage at high water levels. Traverses are normally left at 1,000-foot intervals in pits near levees to prevent levee wash and encourage sedimentation. Traverses are constructed only for haul roads in pits located away from the levee. A typical borrow pit section is illustrated in Figure 4.

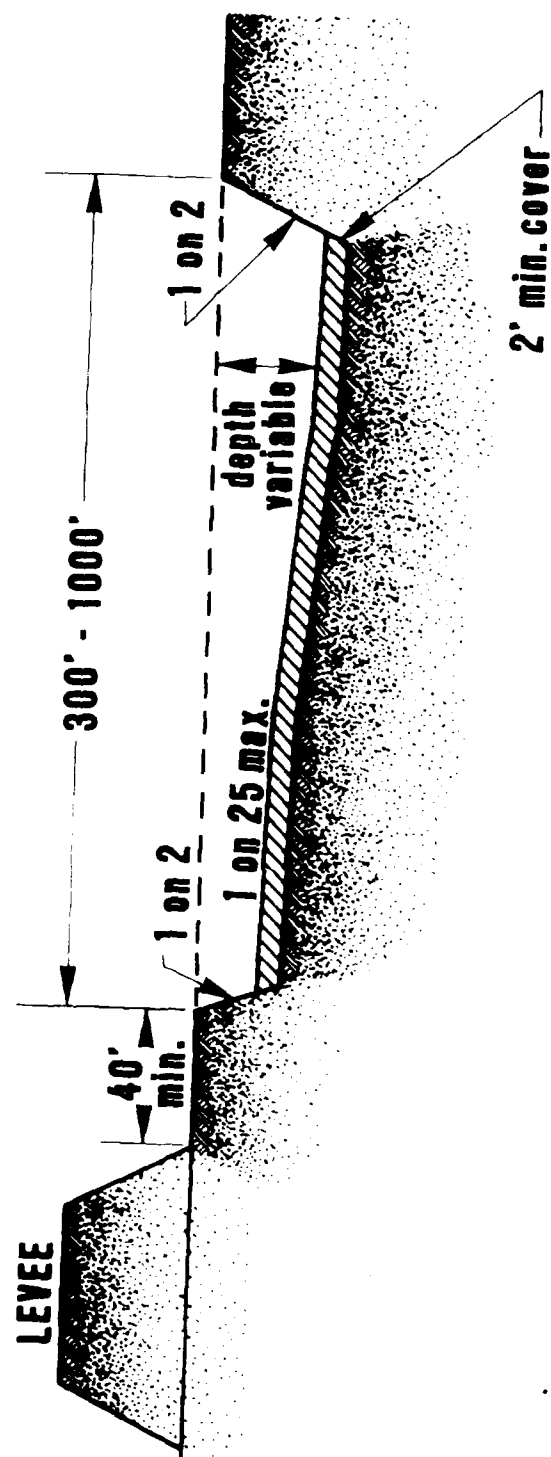


Figure 4. Cross section of typical borrow pit

PART II: METHODS AND MATERIALS

Selection of Borrow Pits for Field Sampling

26. The river was divided into nine 20-mile test reaches by using the 1976 Comprehensive Hydrographic Survey Maps (Table 1). Two hundred thirteen borrow pits were identified from the maps and four parameters were obtained by direct measurement: (a) the borrow pit surface area; (b) the shoreline length; (c) the distance from river channel; and (d) the relative location, that is, location of the borrow pit on a concave, convex or straight river reach. Shoreline Development Index (SDI) was computed for each borrow pit.

27. Principle component analyses were performed on the data, and clusters in which a minimum of principle components were highly correlated enabled the selection of the most important variables for ultimate borrow pit site selection. Summary information from this analysis is presented in Figure 5.

28. Three clusters were identified as follows:

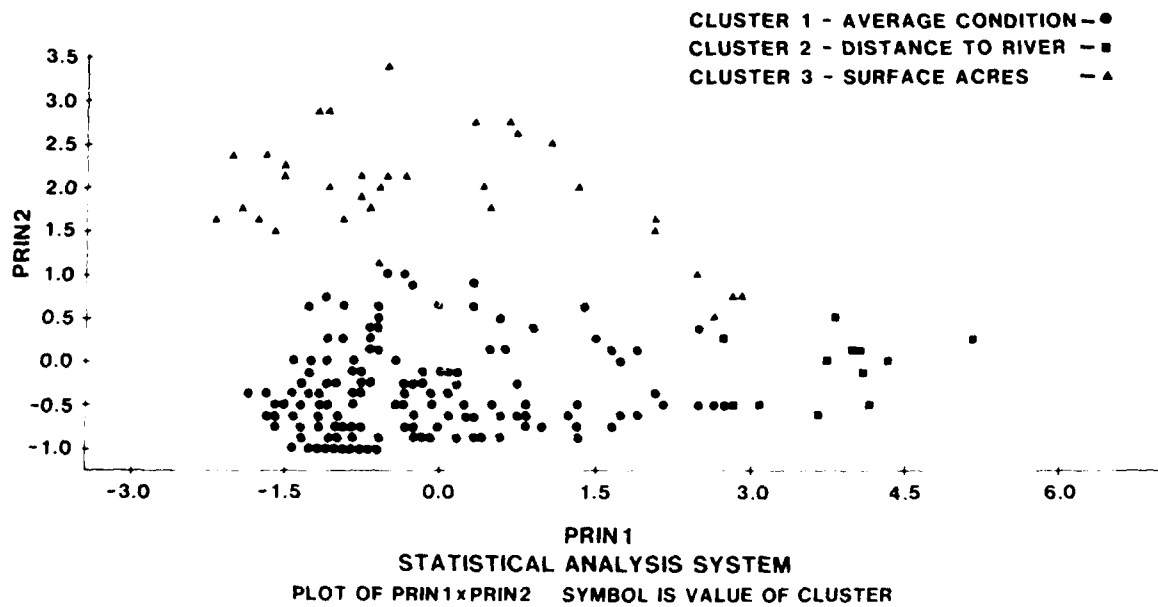
- a. Cluster 1 closely represented the "average" conditions of the borrow pits.
- b. Cluster 2 was principally the distance to the river.
- c. Cluster 3 was based primarily on the surface acres.

Based on this analysis, 25 borrow pits from the 1976 Comprehensive Hydrographic Survey Maps were chosen in proportion to the number of borrow pits in each river reach. Site visits to the selected pits, however, revealed that only 5 of the 25 pits selected for sampling still existed as borrow pits or contained water.

29. Failing the map selection, the selection of borrow pits was given to biologists in the field. Twenty-five borrow pits were selected based on the following criteria: (a) relative distribution of borrow pits on the lower Mississippi; (b) surface area; (c) distance from the river; and (d) ease of access for sampling (Table 2).

Field data collection

30. Water quality and sediment. Transects were established in each borrow pit, with Transect "A" the upstream transect, and Transect "B" the downstream transect. Three stations were placed on each transect. A



NOTE: 37 OBS HIDDEN

Figure 5. Cluster analysis of 213 borrow pits on the Lower Mississippi River based on measurements from the 1976 Hydrographic Survey

middle station was placed equal distance leveeward and riverward between the bank line. The riverward station was placed an equal distance between the middle station and the bank line nearest the river. A leveeward station was placed an equal distance between the middle station and the bank line nearest the levee. Figure 6 displays the transect and station sampling scheme. Water quality variables measured at the surface, mid-depth and/or bottom at each sampling station were taken using a Hydrolab 6D Surveyor in situ analysis system. Variables measured included temperature ($\pm 0.1^{\circ}\text{C}$), dissolved oxygen (± 0.1 milligrams/litre (mg/l)), pH (± 0.1 pH unit), conductivity (± 10.0 micromhos/centimetre (umhos/cm)) and ORP (± 20 millivolts (mv)). In water less than 1 metre deep, only surface measurements were made. A water sample was collected by hand at the middle sampling station for laboratory turbidity analysis. A petite ponar grab sampler was used for sediment analysis at each station. Water and sediment samples were iced and delivered to the WES for analysis. Field data and laboratory analyses are shown in Appendix A for all borrow pits. Visual descriptions of the borrow pits are provided from a combination of field notes and personal observations of the field crews. The presence or absence of vegetation and other cover was also provided by Landin (1985) and is included in Appendix B.

Physical characterization

31. Field surveys. Borrow pit physical data were collected using standard survey techniques. Control points were located on adjacent levees, and using third order procedures, cross sections were taken at approximately 500-foot intervals. A minimum of three cross-section surveys were completed for each borrow pit. The waters' edge and the top bank were located by using the stadia-azimuth method. Contours in borrow pits were developed by using the cross-section surveys. Mapping of borrow pits was accomplished using a drafting machine for plotting. Contouring was accomplished by hand. Volume and area were obtained using an HP9830-A computer with digitizer. Contour maps of the borrow pits along the Lower Mississippi River are displayed in Appendix C.

32. Controlling elevation. Borrow pits are subject to water level fluctuations due to flooding from the Mississippi River, precipitation, runoff, and evaporation. A factor was needed to provide a basis for the

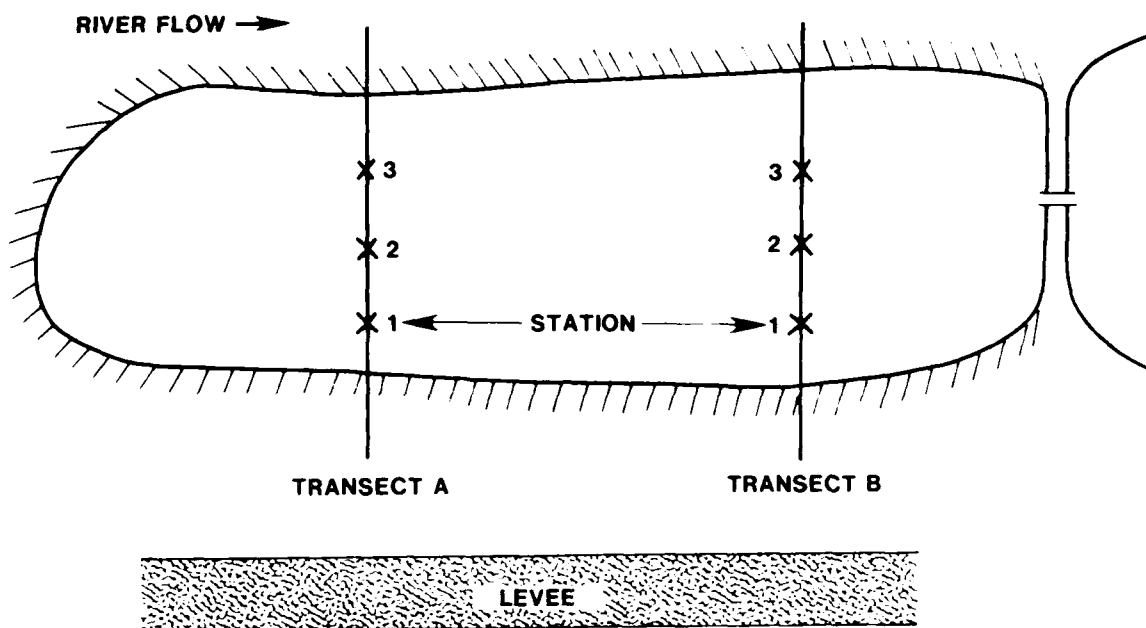


Figure 6. Transect and station sampling scheme for 25 borrow pits along the Lower Mississippi River

comparison between and among pits. Simply recording the water surface elevation during field sampling was considered inadequate because of confounding natural events influencing the water surface elevation at any point in time. The concept of "controlling elevation" was used to calculate constant morphometric parameters. The controlling elevation is that elevation at which water will freely flow into or out of a borrow pit, and were estimated from field observations and elevation data from the Comprehensive Hydrographic Survey Maps. Controlling elevation can be a point of low ground on the bank or the lower elevation of a culvert connecting several borrow pits. Appendix A lists controlling elevations. Contour maps in Appendix C indicate the controlling elevation as well as surface water elevation at the time of survey for each borrow pit.

33. Shoreline Development Index (SDI). The relative amount of shoreline development of irregularity can be expressed as a ratio of shoreline length to the circumference of a circle that has the same area as the lake. The formula (Welch 1948) used to determine the SDI is as follows:

$$SDI = \frac{L}{2 \sqrt{A}}$$

where

L = shoreline length

A = surface area of borrow pit

The smallest possible value, 1, would indicate a lake with a circular shape. Increased values of SDI denote greater shoreline irregularity and an increasing potential for littoral activity.

34. Volume Development Index (VDI). The VDI compares the basin shape to an inverted cone with a height equal to the maximum depth and a base equal to the surface area of the lake. The simplified formula (Welch 1948) used to obtain the VDI is:

$$VDI = 3 \frac{\bar{d}}{D_m}$$

where

\bar{d} = Mean depth

D_m = Maximum depth

35. Mean Basin Slope (MBS). The slope between adjacent borrow pit contours was found using the formula (Welch 1948):

$$S = \frac{C_1 + C_2}{2} \times \frac{I}{A}$$

where

S = the slope of the adjacent contours in percent

C₁ and C₂ = lengths of adjacent contours

I = interval between contours

A = area of the bottom contour

36. The MBS is the average change in depth per unit of horizontal distance and was calculated by using the following formula:

$$MBS = \frac{1/2 C_0 + C_1 + C_2 + C_3 + \dots + C_{n-1} + 1/2 C_n}{n} \cdot \frac{D_m}{A}$$

where

MBS = mean basin slope in percent

C₀, C₁, C₂ = Length of contour

n = the number of contours

D_m = Maximum depth

A = surface area

Laboratory analysis

37. Turbidity. A Model 2100A Hach Turbidimeter was used to measure turbidity. Calibration was performed prior to each measurement.

38. Sediments. A US Standard Sieve Size analysis was performed on all sediment samples (Department of the Army 1970). Sieve sizes ranged from the largest sieve size that would practically pass 100 percent of material (the largest used was 101.6 mm) to 0.062 mm, or that size separating the silt-clay fraction. Percent volatile matter was used to estimate the organic content of sediments. Ignition of sediment samples was conducted at 550 ± 50°C for one hour. Samples were cooled in a dessicator and brought to constant weight. Weight loss on ignition is reported as percent volatile residue.

PART III: RESULTS

Physical Description of Study Borrow Pits

Surface area

39. Borrow pits ranged in size from 3.3 to 53.4 acres with a mean surface area of 19.2 acres (Table 3). Although the median acreage was 11.0 acres, 17 pits contained less than 20 acres and only 2 pits contained more than 50 acres. A total of 479 surface acres of borrow pits was studied.

Shoreline length

40. The intersection of land with permanent water is of nearly constant length in most natural lakes (Wetzel and Likens 1979). The length of the shoreline in borrow pits, however, can fluctuate widely in response to rainfall and flooding. Shoreline length is an important morphometric parameter because it indicates the extent of the littoral zone which is the most biologically productive region of a lake. In this survey the shoreline length of islands within borrow pits was included in total shoreline length of the pit.

41. Shoreline length ranged from 1,916 feet for Borrow Pit 9 to 15,225 feet for Borrow Pit 25 (Table 3). The mean shoreline length was 6,471 feet, and the median was 4,693 feet with even distribution throughout the range of values. Seventeen of the 25 borrow pits had less than 6,000 feet of shoreline.

42. Although data analysis showed a correlation ($r = 0.83$, $df = 23$) significant at the one percent level between shoreline length and surface area (Table 4), this relationship was not consistent for all pits. Several pits were of similar size but showed large differences in shoreline lengths. The surface area of Borrow Pits 25, 17, and 3 ranged from 36.9 to 39.6 acres. However, the shoreline of Borrow Pit 3 was approximately one-half as long as the shoreline of Borrow Pit 17 and only one-third that of Borrow Pit 25. Borrow Pits 13 and 15 contained the same acreage, 53.4 acres, but the shoreline of Borrow Pit 13 was 5,100 feet or 37 percent longer than that of Borrow Pit 15. Borrow Pits 8, 23, and 2 contained 16.2, 17.7, and 18.7 acres, respectively; yet Borrow Pit 23 had 2,049 feet

more shoreline than Borrow Pit 8, and 3,011 feet more than Borrow Pit 2. Conversely, Borrow Pits 8 and 3 had approximately the same amount of shoreline, but the surface area of Borrow Pit 8 (16.2 acres) was only 40 percent that of Borrow Pit 3 (39.6 acres). Borrow Pit 4 had a shoreline length of 9,500 feet, greater than double that of Borrow Pit 5, but exhibited almost 3 times the surface acres.

Shoreline development index

43. Shoreline irregularity reflects the potential for development of the littoral community. The combination of in-lake, or autochthonous productivity, the allochthonous detrital and nutrient input from the surrounding terrestrial environment, and eventual decomposition of this material in bottom sediments makes the shallow water of the shoreline a biologically productive zone. In this study, SDI values ranged from 1.2 for Borrow Pit 3 to 3.7 for Borrow Pit 6; the mean value was 2.2 and the median was 2.0 (Table 3). Shoreline length and SDI were significantly correlated at the one percent level ($r = 0.71$, $df = 23$) (Table 4). The plot of shoreline length to SDI showed four groups of borrow pits based on this relationship (Figure 7). Thirteen pits with less than 6,000 feet of shoreline had SDI values ranging from 1.2 to 2.0, and three pits had shorelines of 9,500 to 11,000 feet with SDI's of 2.3 to 3.0. Eight pits showed SDI values of 2.6 or greater; however, the shorelines of Borrow Pits 13, 14, 24, and 25 were greater than 10,000 feet, whereas, those of Borrow Pits 6, 11, 18, and 22 were less than 6,000 feet. All borrow pits with an SDI greater than 2.2 were long and narrow with the exception of Borrow Pit 6. Borrow Pit 25 with the second highest SDI (3.4) was very long and was the narrowest pit studied. Borrow Pit 6, however, was a square-shaped pit which was divided into compartments by peninsulas protruding into the pit. Borrow Pit 15 fit into none of the above described groups. Based on Borrow Pit 15's shoreline length, 8,881 feet, the SDI value should have been within the middle range of SDI values 2.0 to 2.2; however, the borrow pit was wide as compared with its length and the resulting SDI was low, $SDI = 1.6$. Borrow Pit 24, $SDI = 3.1$, had a SDI value higher than Borrow Pit 14, $SDI = 3.0$, but the latter had 4,268 more feet in its shoreline. Although both pits were long and narrow, Borrow Pit 24 was not as wide as Borrow Pit 14. It therefore, contained more shoreline per surface area and reflected a slightly larger SDI.

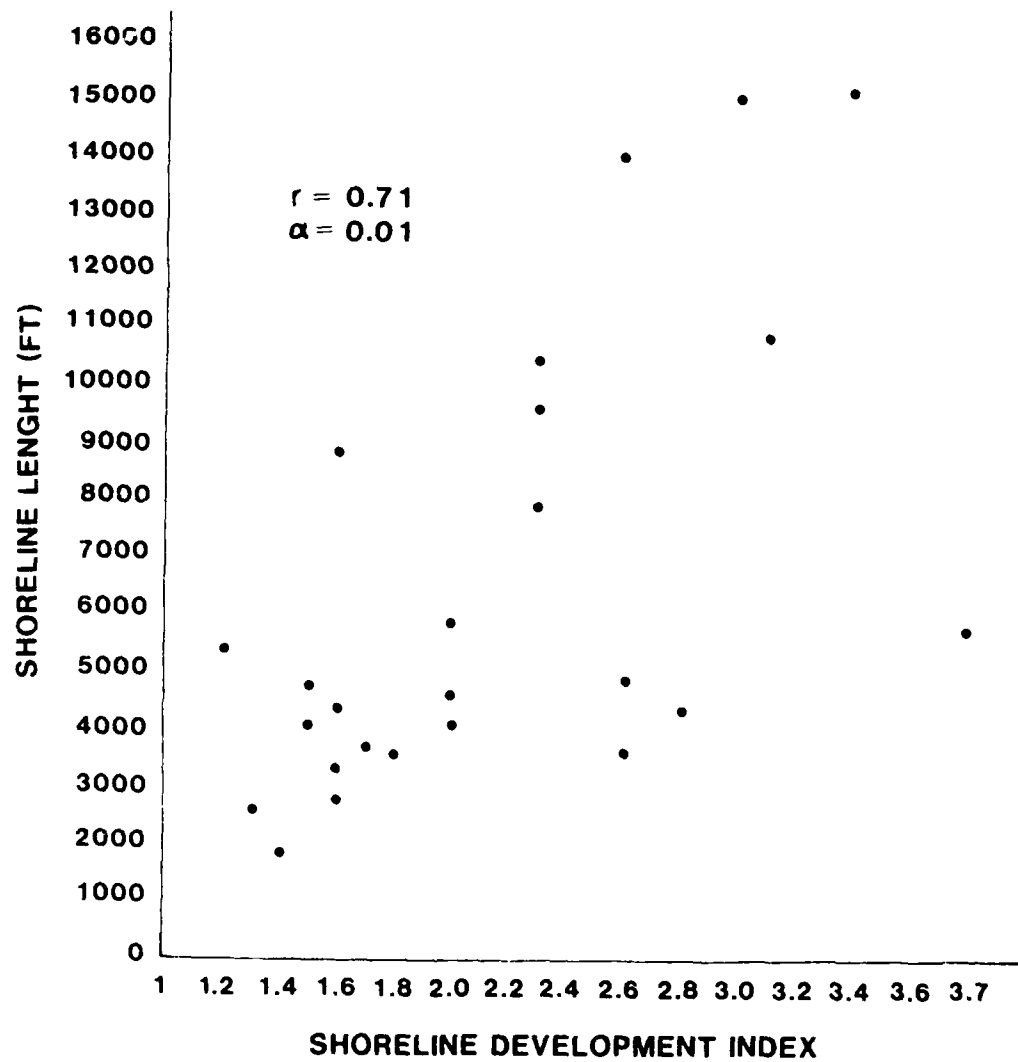


Figure 7. Plot of shoreline length of shoreline development index, for 25 borrow pits along the Lower Mississippi River

44. In general, the long, narrow borrow pits tended to provide more shoreline per surface acre than smaller, more square borrow pits. The presence of peninsulas and islands significantly affected shoreline length, and tended to increase the SDI value.

Subsurface Dimensions

Maximum and mean depths

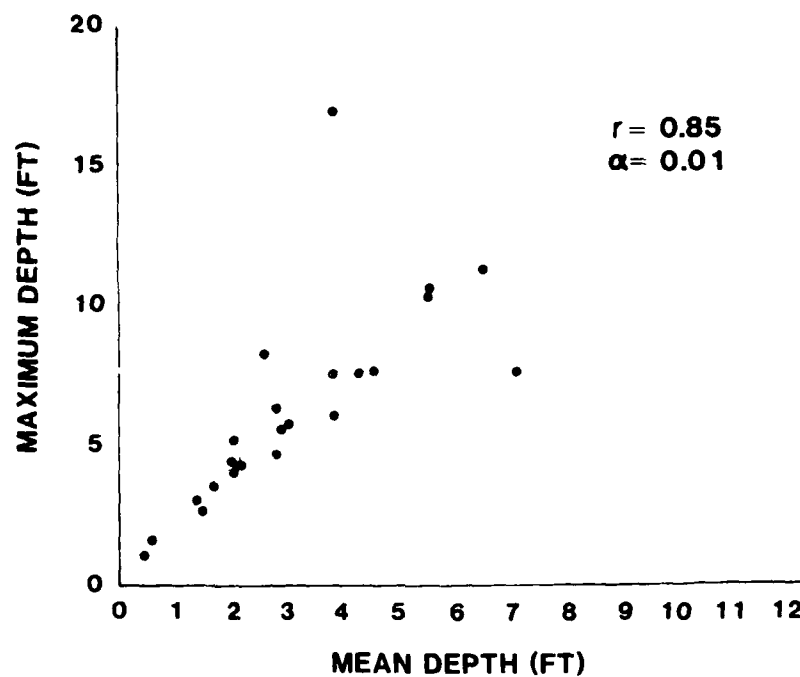
45. Maximum depths ranged from 1.1 feet in Borrow Pit 19 to 17.7 feet in Borrow Pit 22; average maximum depth for all borrow pits was 6.5 feet, and the median was 5.3 feet (Table 3). Borrow Pits 11 and 19 were less than 2 feet deep; Borrow Pits 1, 2, 13, 22, and 25 had depths greater than 10 feet; and 18 pits showed maximum depths between 2.7 and 8.2 feet. Mean depth is the volume of the pit divided by the surface area. Mean depths ranged from 0.5 feet in Borrow Pit 19 to 7.2 feet in Borrow Pit 22. The mean depth for all pits was 3.1 feet. Nineteen borrow pits had mean depths of less than 4 feet.

46. A high correlation ($r = 0.85$, $df = 23$) significant at the one percent level was found between mean and maximum depths (Table 4), and a graph of these variables showed two major groupings of pits based on depth relationships (Figure 8). Six pits with mean depths greater than 4 feet had maximum depths greater than 7.0 feet, and 13 pits with mean depths between 1.0 and 3.0 feet had maximum depths of 2.7 to 6.2 feet. Borrow Pit 13, however, had a mean depth of less than 4 feet but a maximum depth of 16.9 feet.

47. Mean depth showed a negative correlation significant at the five percent level ($r = -0.49$, $df = 23$) with borrow pit location on the river. The 6 borrow pits with mean depths greater than 4 feet were located below RM 432; whereas, 13 of the borrow pits with mean depths of 3 feet or less were located above RM 432 (Figure 9).

Volume

48. Borrow pit volume ranged from 4,056 cubic yards for Borrow Pit 11 to 348,228 cubic yards for Borrow Pit 15 (Table 3). The mean volume was 102,687 cubic yards, and the median volume was 48,404 cubic yards.



• **HIDDEN OBSERVATION**

Figure 8. Plot of maximum depth versus mean depth for 25 borrow pits along the Lower Mississippi River

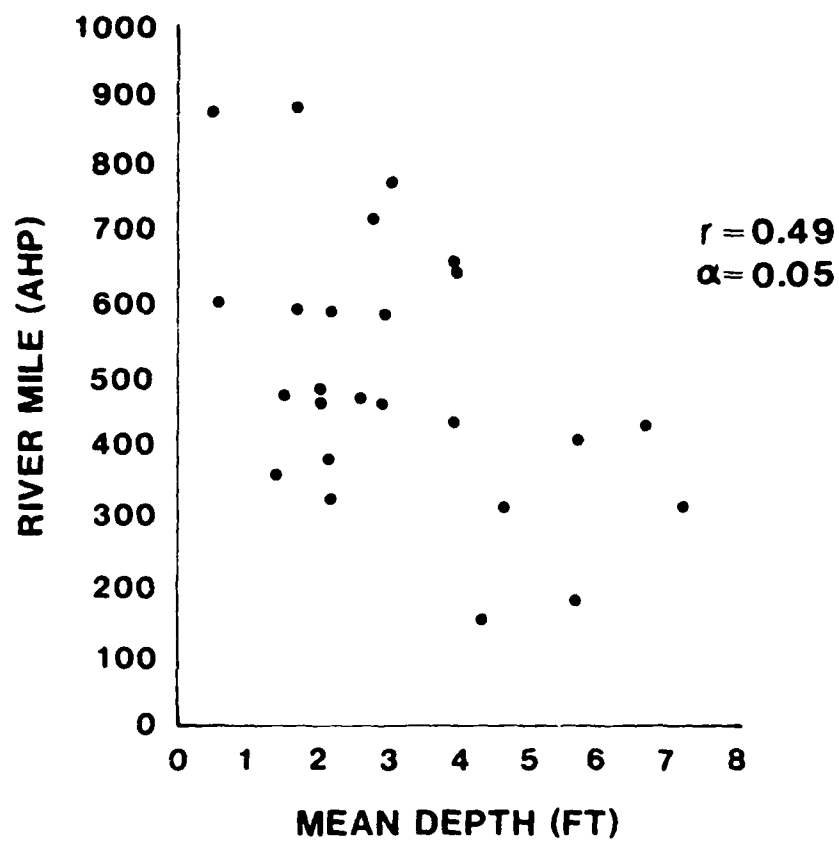


Figure 9. Plot of river mile versus mean depth of 25 borrow pits along the Lower Mississippi River

49. A correlation ($r = 0.91$, $df = 23$) significant at the 1 percent level was found between volume and surface area and reflects the generally shallow excavations used to provide levee material. Ten borrow pits containing less than 10 acres of surface area were less than 25,000 cubic yards in volume. All pits larger than 30 acres had volumes greater than 100,000 cubic yards, and Borrow Pits 13 and 15 with the largest acreages, 53.4 acres each, had the greatest volume, 309,178 cubic yards and 348,228 cubic yards, respectively.

50. Data analysis revealed a correlation ($r = 0.81$, $df = 23$) significant at the 1 percent level between volume and shoreline length. Fourteen borrow pits had shorelines of less than 6,000 feet and volumes of less than 75,000 cubic yards; whereas, 3 borrow pits had shorelines of 14,000 to 15,000 feet and volumes between 224,000 and 325,000 cubic yards (Figure 10). The graph showed two groups of borrow pits between these extremes. The shorelines of Borrow Pits 1, 2, and 3 ranged between 4,000 and 6,000 feet, and the volumes were between 130,000 and 180,000 cubic yards; Borrow Pits 4, 17, 23, and 24 had shorelines of 7,500 to 11,000 feet but volumes between 75,000 and 185,000 cubic yards. Borrow Pit 15 showed the greatest volume but had a shoreline length of only 8,881 feet.

Indices to Basin Shape

Volume development index (VDI)

51. The VDI is used to describe the relative shape of a lake basin. A VDI of 1 depicts a lake basin with a height equal to the maximum depth of a lake and base equal to the surface area, and the volume, therefore, equal to a hypothetical cone; and index greater than 1 indicates the lake has a concave basin and a volume greater than the cone; whereas, an index less than 1 indicates the basin has a convex basin and a smaller volume than the hypothetical cone.

52. The data indicated that most of the borrow pits had concave basins, as only two pits (Borrow Pits 3 and 13) had VDI values of less than 1 (Table 3). The mean VDI was 1.5, with 17 pits indicating values of 1.5 or greater; Borrow Pit 6 had the highest VDI of 1.9. There were no significant correlations between VDI and other physical variables (Table 4).

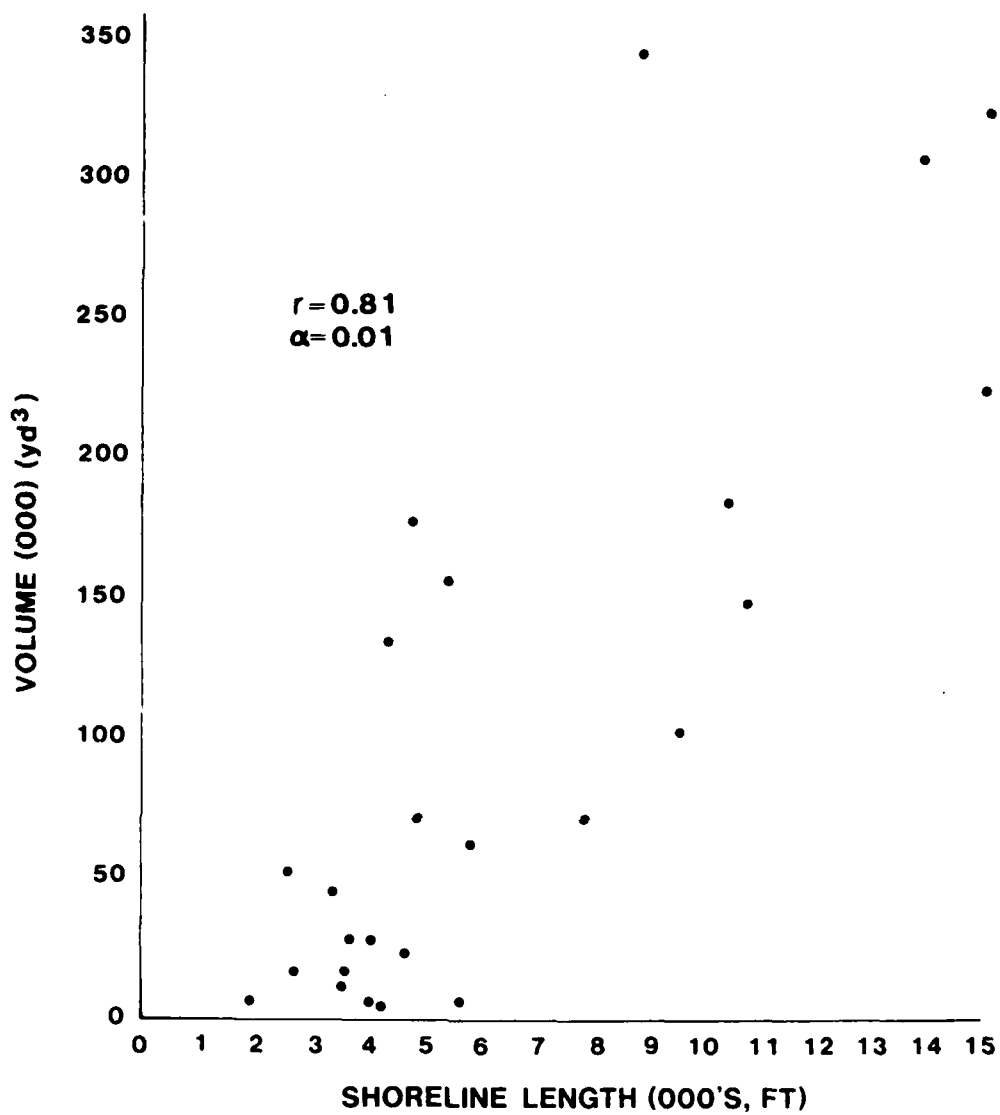


Figure 10. Plot of volume versus shoreline length for 25 borrow pits along the Lower Mississippi River

Mean basin slope (MBS)

53. The MBS was very flat for all borrow pits. The MBS ranged from 0.01 percent for Borrow Pits 5 and 19 to 0.14 percent for Borrow Pit 22 (Table 3). The mean and median values were 0.04 and 0.03 percent, respectively. Sixteen borrow pits had values of 0.03 percent slope or less.

54. The MBS showed a strong correlation significant at the one percent level with mean depth ($r = 0.78$, $df = 23$) and maximum depth ($r = 0.79$, $df = 23$) (Table 4). Seventeen borrow pits had mean slopes of 0.03 percent or less, mean depths of less than 4.0 feet, and maximum depths less than or equal to 8.2 feet. Borrow Pits 1, 2, 20, 22, 24, and 25 had mean slopes 0.05 percent or greater, mean depths greater than 4 feet, and maximum depths greater than 7 feet. Borrow Pits 13 and 18 showed an MBS of 0.05 percent and mean depths less than 4.0 feet; the maximum depth of Borrow Pit 18 was only 5.1 feet, but that of Borrow Pit 13 was 16.9 feet.

55. Borrow Pit 22 showed the greatest depth, 17.7 feet, and the greatest MBS of 0.14 percent. The maximum slope of 0.52 percent was measured in Borrow Pit 6. This occurred between the surface and 0.8 foot contour. Inspection of Plate 6 shows this sharp slope was the result of fairly deep cuts which isolated peninsular features in the borrow pit.

56. Borrow pits along the upper river had less slope than those on the lower river. The MBS showed a negative correlation ($r = -0.50$, $df = 23$) significant at the 0.05 level with river mile location. Of the 16 pits above RM 432, 16 showed an MBS of at least 0.03 percent or less; whereas 7 of the 9 pits below RM 432 had an MBS of 0.05 percent or greater. Borrow Pits 6 and 13 were the only borrow pits between RM 432 and 881 that had MBS's greater than 0.05 percent.

Sediment

57. Samples obtained from the top layer of borrow pit sediments were washed through a series of sieves to separate the various particle sizes. The data showed that sediment from most of the borrow pits consisted chiefly of silt and clay. The average silt-clay fraction of sediment samples ranged from a low of 54.6 percent silt-clay in Borrow Pit 13 to 99.6 percent silt-clay in Borrow Pit 5 (Table 3); the average silt-clay

fraction was 88.8 percent and the median was 95.3 percent. Silt and clay composed at least 90 percent of the sediments from 16 borrow pits and at least 80 percent of the sediment from 4 pits; only 5 pits contained 75 percent silt and clay or less (Table 5). Sediments other than silt-clay were chiefly fine and very fine sands. Borrow Pits 10, 16, and 21 contained more than 20 percent very fine sand; Borrow Pit 13 with the least amount of silt and clay had 26 percent fine sand and 16 percent very fine sand; and Borrow Pit 15 showed a variety of particle sizes ranging from fine gravel to very fine sand. The distribution of sediment by size fraction for all borrow pits is shown in Figure 11.

Volatile residue

58. Volatile residue was used as an estimate of the organic matter in borrow pit sediments. The borrow pit data showed uniform but low volatile residue, ranging from a low of 3.4 percent volatile residue in Borrow Pit 3 to 10.0 percent volatile residue in Borrow Pit 15 (Table 5). The mean was 5.7 percent volatile residue, and the median was 5.5 percent. The greatest single volatile residue measurement, 18.4 percent, was taken from Borrow Pit 15. There were no significant statistical relationships between volatile residue and sediment size, position and location on the river, days flooded, or other morphometric characteristics (Tables 4 and 7).

Flooding

59. Flooding of borrow pits along the Mississippi River is dependent upon river stage. The controlling elevation was used to calculate the period of flooding at each study location from 1973 through 1981. The year 1973 was chosen as the base year because all the borrow pits were inundated by the 1973 flood. All pits received flooding during 5 other years, 1974, 1975, 1978, 1979, and 1980, and approximately 80 percent of the pits were flooded in 1976, 1977, and 1981 (Appendix A).

60. In 1973 the borrow pits were flooded an average of 182 days, or 50 percent of the possible days in one year (Table 6). Average annual flooding of borrow pits reached a low of 14 days in 1977 and 16 days in 1981. Borrow Pits 2, 13, 15, 17, and 21 did not flood in 1976, 1977, or 1981; and Borrow Pit 22 was flooded only 1 day during those years.

**PERCENT FINER SEDIMENT PASSING THROUGH A 230 MESH SIEVE
FROM EACH OF 25 STUDY BORROW PITS**

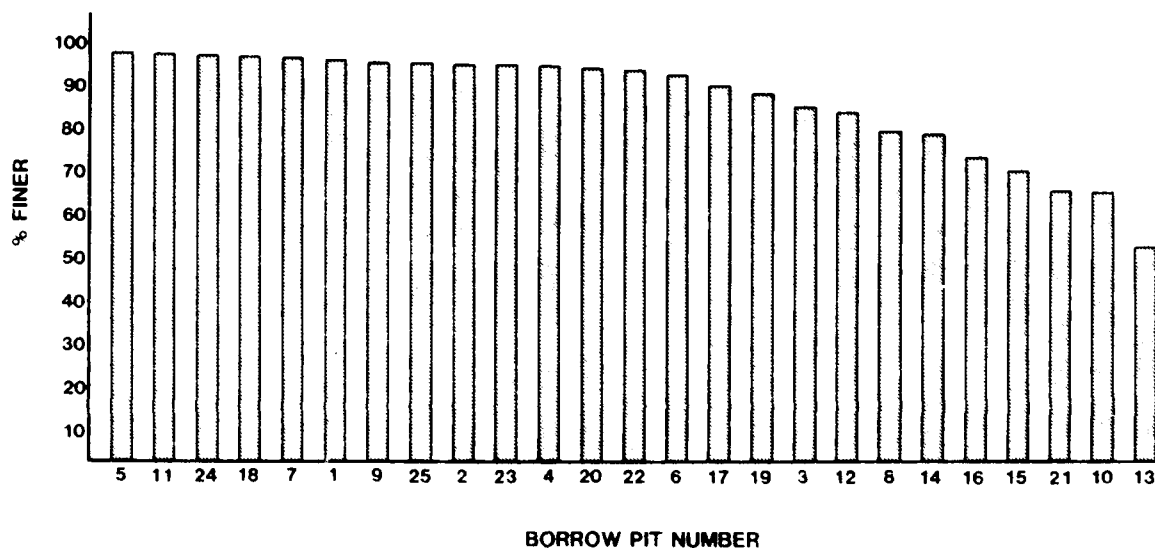


Figure 11. Average borrow pit sediment size arranged from finest to most coarse, by pit

Water Quality and Sediment

61. Basic water chemistry and sediment data were taken at each borrow pit concurrent with biological sampling. The purpose of the data was to describe the borrow pit water quality for fishery purposes and to characterize the substrate. Inspection of the data, however, revealed relationships among morphological and physical features of the borrow pits as shown in Table 7 and as discussed below.

62. Temperature. Surface temperatures ranged from a low of 26.5°C in Borrow Pit 10 sampled on 6 July 1981, to a high of 35.5°C measured in Borrow Pit 19 on 26 July 1981. There were no within-pit transect or station trends observed for temperature. Average surface water temperatures for all borrow pits averaged 31.6°C. Those borrow pits sampled during June (Borrow Pits 1 through 9) averaged 28.4°C, while those sampled in July (Borrow Pits 10 through 23) averaged 31.4°C. Borrow Pits 24 and 25 were sampled in early August. Their average surface temperature was 31.7°C. The few subsurface temperature samples taken at 1-m intervals showed classic thermal stratification. A correlation matrix of water chemistry variables to physical attributes (Table 7) indicated a negative correlation at the 5 percent level of significance ($r = -0.46$, $df = 23$) for average surface temperature versus average annual days flooded. The relevance of this relationship is unclear, however, since there was no significant correlation between surface temperature versus river mile nor with temperature versus time of sampling. On a broad scale, borrow pits above Vicksburg (RM 430) flood an average of 80 days per year, whereas those below Vicksburg flood an average 86 days. Thus, flooding duration may influence borrow pit surface water temperatures.

63. Dissolved oxygen/oxidation reduction. Surface dissolved oxygen measurements ranged from a low of 0.1 mg/l at Borrow Pit 18 on 23 July to a high of 12.3 mg/l at Borrow Pit 8 on 29 June. Oxygen saturation values ranged from a low of 1 percent in Borrow Pit 18 to a high of 173 percent in Borrow Pit 4 on 19 June. Average surface dissolved oxygen concentration for all borrow pits was 6.5 mg/l with an average saturation value of 91.6 percent.

64. There were no within-pit transect or station trends observed for dissolved oxygen. A correlation $r = 0.53$ ($df = 23$) significant at the 1 percent level between average surface dissolved oxygen concentration and river mile, and between dissolved oxygen and controlling elevation ($r = 0.50$, $df = 23$) significant at the 5 percent level, and other similar correlations for saturation values and these same physical variables (Table 7) indicated a trend of increasing dissolved oxygen values from south to north in the Lower Mississippi River Valley. There were no other significant correlations between dissolved oxygen and other physical or morphological variables. A correlation of $r = 0.70$ ($df = 23$) significant at the 1 percent level existed between time of sampling and average surface dissolved oxygen concentration. A plot of average surface dissolved oxygen versus time of sampling is shown in Figure 12 and suggests the influence of algal and macrophyte oxygen production on the dissolved oxygen concentrations in the borrow pits.

65. Oxidation Reduction Potential (ORP) readings were taken to indicate oxidizing or reducing conditions in borrow pit waters. The ORP readings can also indicate general chemical processes in natural waters which may be used to explain observed limnological processes. The 0.2 volt isovolt (200 mv) is a commonly accepted indicator of the interface between predominantly oxidizing and reducing conditions (Hutchinson 1957; Mortimer 1969). The 200 isovolt is based on empirical chemical equations corrected for pH 7 which indicate the reduction of ferric ion to ferrous ion (Fe^{+++} to Fe^{++}) in the range from 300 mv to 200 mv, and sulfate ion to sulfide ion ($SO_4^{=}$ to $S^{=}$) at an E_7 ranging from 100 mv to 60 mv. The ORF values of 200 mv or greater were present in 22 of 25 borrow pit surface waters. Borrow Pits 5, 14, and 18 exhibited ORP measurements less than 200 mv, however, only one borrow pit was observed to be in a reducing state. Borrow Pit 18 exhibited the classic reducing symptoms: low dissolved oxygen ($x DO = 0.6$ mg/l); higher than average conductivity (x conductivity = 515 umhos); neutral to slightly acid pH (pH range 6.9 to 7.0); and ORP measurements ranging from 55 mv to -125 mv. Field notes indicated that Borrow Pit 18 contained a "noticeable black layer" on the bottom. Borrow Pit 18 did not exhibit any apparent unique physical or morphological conditions which could have encouraged this condition.

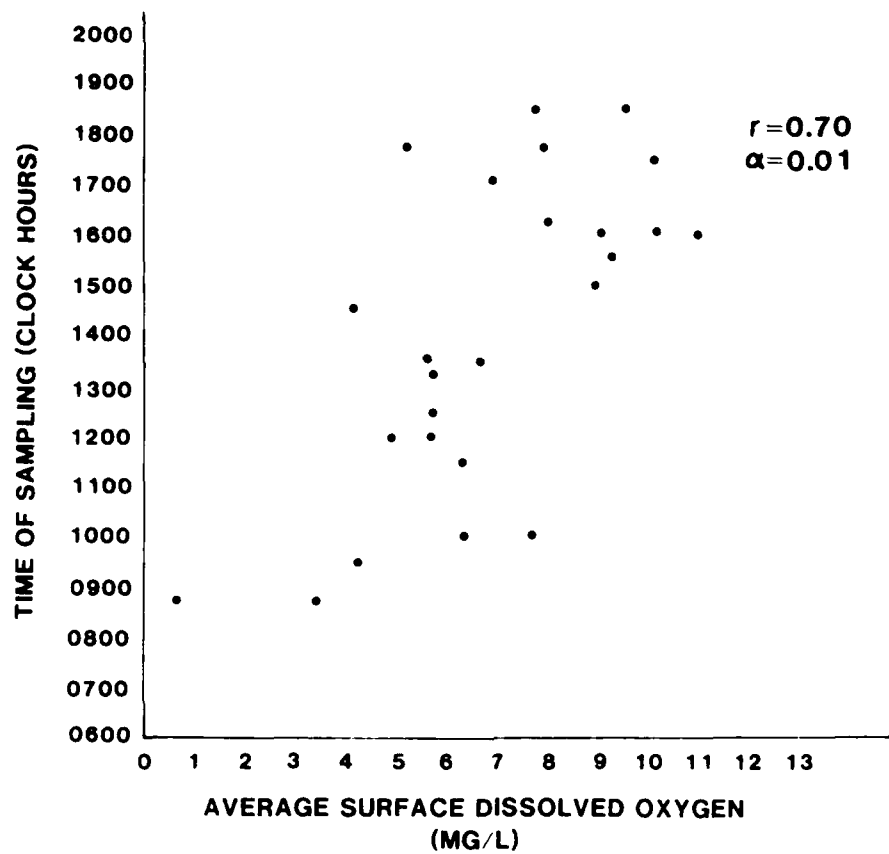


Figure 12. Plot of average surface dissolved oxygen versus time of sampling for 25 borrow pits along the Lower Mississippi River

66. pH. Surface pH readings ranged from a low of pH 6.9 in Borrow Pit 18 to a high of pH 9.5 in Borrow Pit 19. Median pH for all borrow pits was 8.1. There were no significant within-pit transect or station trends observed for pH. Mean pH exhibited significant correlations at the 5 percent level of significance for river mile ($r = 0.42$, $df = 23$) and controlling elevation ($r = 0.41$, $df = 23$). Likewise, mean pH was positively correlated at the 1 percent level of significance ($r = 0.59$, $df = 23$) with time of sampling (Figure 13). pH can also be used as an indicator of biological activity by observing the variations in daily pH fluctuations with those of other parameters, notably dissolved oxygen. As algae and aquatic plants grow during daylight hours, they use carbon dioxide in the water and produce oxygen. At night, the plants and animals will consume oxygen and respire carbon dioxide. Oxygen consuming processes such as decomposition in the muds continue at night and result in the release of carbon dioxide which forms carbonic acid which results in a drop of pH. Thus, dissolved oxygen and pH will tend to fall after dark, reaching minimal levels before dawn. Figures 12 and 13 indicate these processes occur in borrow pits on a daily basis, and produce large changes in the aquatic medium.

67. Conductivity. Average surface conductivities ranged from a low of 205 micromhos in Borrow Pit 2 to a high of 515 micromhos in Borrow Pit 18. The mean conductivity for all borrow pits was 328 micromhos. There was no significant relationship between either conductivity and any physical or morphological variables (Table 7).

68. Conductivity is a measurement which expresses the ability of an aqueous solution to carry an electrical current. The concentration of ions in solution, their valence and other characteristics, as well as temperature, determine the conductivity reading. Mississippi River conductivities at Vicksburg range from high values near 500 micromhos to low values near 250 micromhos. During the high flow winter and spring seasons, conductivities typically are low (Figures 14 and 15), thus lower conductivity water would be more likely to enter borrow pits than water high in conductivity. Analysis of days of flooding in 1981 versus average surface conductivities, however, did not yield any significant relationship. Nor was there a significant relationship between time of sampling versus conductivity. There was, however, a significant negative relationship between average surface temperature and average surface conductivity ($r = -0.40$, $df = 23$) at the

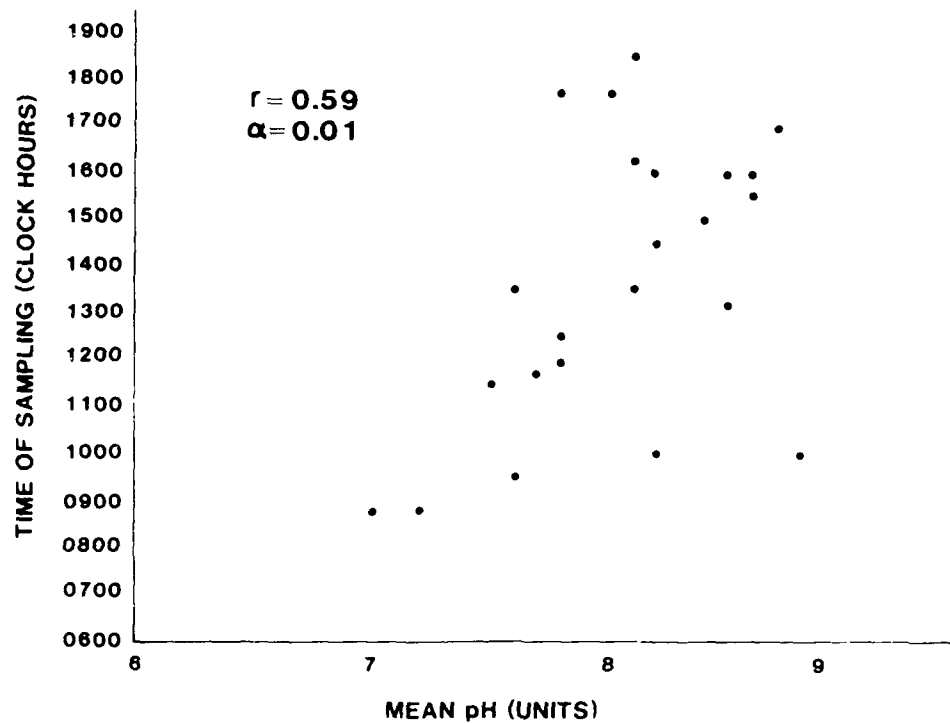


Figure 13. Plot of mean surface pH versus time of sampling for 25 borrow pits along the Lower Mississippi River

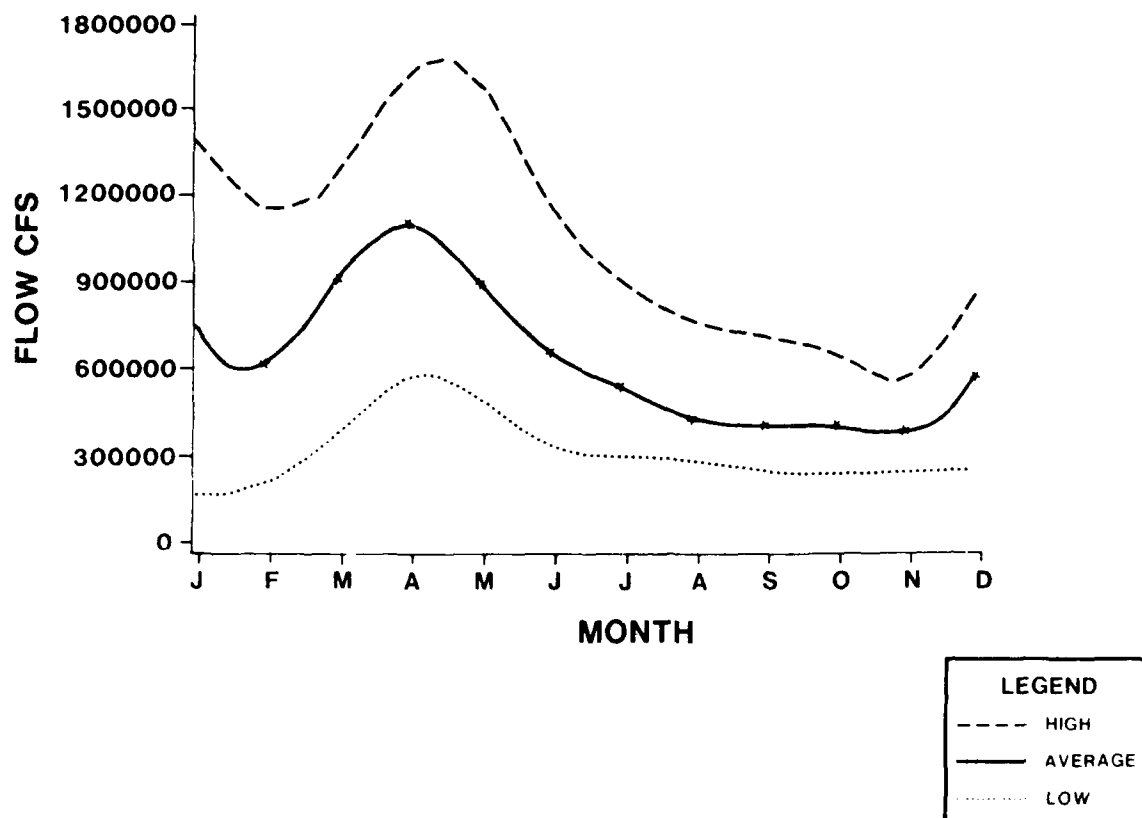


Figure 14. Plot of monthly range of flow readings for the Mississippi River at Vicksburg, January 1974 to January 1984

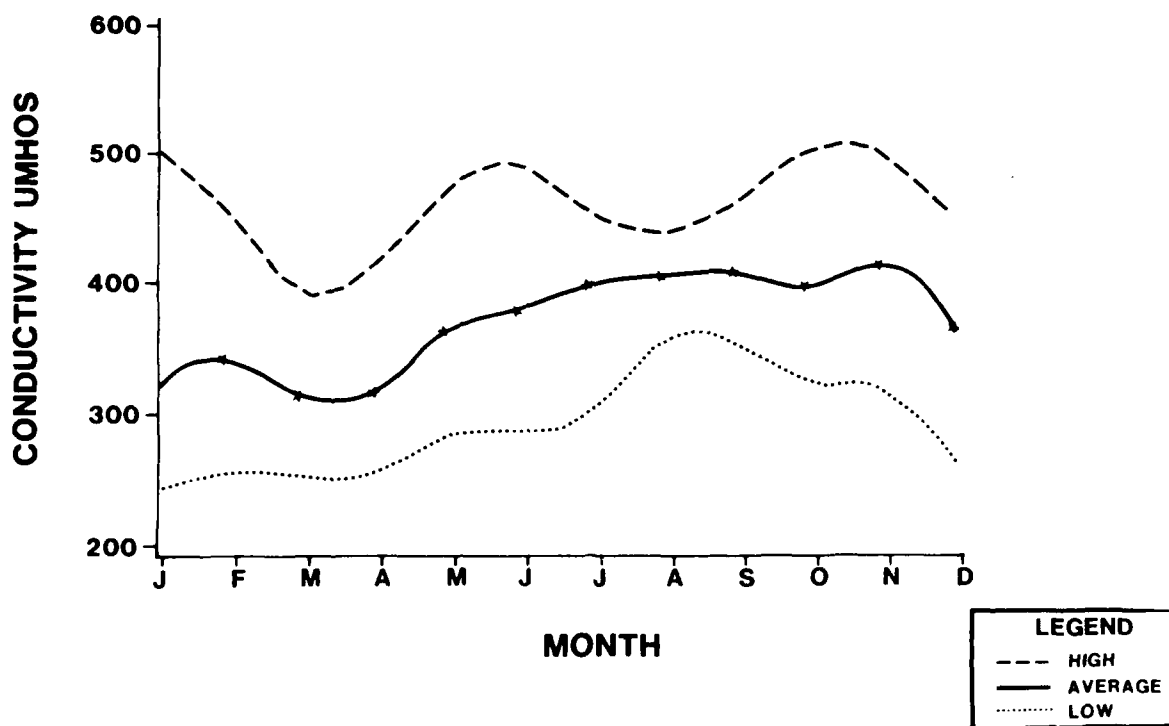


Figure 15. Plot of monthly range of conductivity readings for the Mississippi River at Vicksburg, January 1974 to January 1984

5 percent level, and between mean surface pH and average surface conductivity at the 10 percent level ($r = -0.38$, $df = 23$) (Table 8). This suggests that conductivity or total ion concentration in borrow pits is more closely tied to within-borrow pit chemical and biological processes than to major physical influences such as flooding, location, basin shape or volume.

69. Turbidity and Secchi Disc. Turbidity is caused chiefly by suspended matter in water. Turbidity is a measure of the optical property of water that causes light to be scattered and absorbed rather than transmitted in straight lines (American Public Health Association (APHA) 1980). Secchi disc, however, measures visibility in a water column. The depth at which a Secchi disc can be seen depends on the reflectivity of the water surface, light alteration by dissolved substances (absorption) and light scattering due to turbidity (Brezonik 1978). Surface turbidity in the borrow pits ranged from a high of 78 Nephelometric Turbidity Units (NTU) in Borrow Pit 21, to a low of 8 NTU's in Borrow Pit 13. Average surface turbidity over all borrow pits was 24 NTU's. Secchi disc depth ranged from a low reading of 0.1 m in Borrow Pits 2, 5, 7, 11, 14, 16, 19, 20, 21, and 24 to a high of 0.7 m in Borrow Pit 3. The average Secchi disc depth for all borrow pits was 0.3 m. As expected, a negative correlation between average surface turbidity and average Secchi disc depth ($r = -0.70$, $df = 22$) significant at the 1 percent level was noted. However, a positive correlation between the average surface turbidity and the distance to river ($r = 0.54$, $df = 22$), significant at the 1 percent level, and negative correlation between Secchi disc and distance to river ($r = -0.35$, $df = 23$) at the 10 percent level was calculated. There appears to be a relationship between the distance to the Mississippi River and clarity of the water in the borrow pits; however, there are no other strong relationships apparent with this survey data to provide adequate explanation.

70. Secchi disc was positively correlated with mean and maximum depth ($r = 0.46$, $r = 0.60$, $df = 23$, respectively) significant at the 5 percent and 1 percent levels, respectively, and volume and MBS ($r = 0.35$, $r = 0.38$, $df = 23$, respectively) significant at the 10 percent level. Thus, the greater the depth and volume of water in the borrow pits, the greater the Secchi disc depth.

71. Sediments and volatile residue. Sediments from the 25 borrow pits were composed chiefly of silt-clay, with an average silt-clay fraction of 88.8 percent (Table 5). The highest silt-clay fraction was sampled in Borrow Pit 5 and averaged 99.6 percent. The borrow pit with the lowest silt-clay fraction was Borrow Pit 13 with 54.6 percent silt-clay.

72. Volatile residue, used as an indicator of organic material, was considered low and fairly consistent across all borrow pits. The average volatile residue for all borrow pits was 5.7 percent and ranged from a low of 0.9 percent at a riverward station in Borrow Pit 6 to a high of 11.1 percent on a leveeward station in Borrow Pit 15. Percent silt-clay was negatively correlated with river mile ($r = -0.39$, $df = 23$) at the 10 percent level of significance. This observation tends to agree with particle size data which shows the size of suspended particles tends to decrease from north to south in the river channel (Keown, Dardeau, and Causey 1981). The percent silt-clay was also negatively correlated with surface area ($r = -0.40$, $df = 23$) and was significant at the 5 percent level. Average annual days flooded and percent silt-clay was positively correlated at the 10 percent level of significance ($r = 0.39$, $df = 23$). This suggests that those borrow pits which experience greater numbers of flooded days tend to have finer materials in their sediments.

PART IV: DISCUSSION

73. Borrow pits have been excavated along the Mississippi River since levees were constructed in the 1700's. The basic requirement for their construction is based on economics; that is, secure the required material as close to the levee and with the shortest haul distance possible. Although the manner in which material has been excavated has changed through the years, the economical requirement remains. This has resulted in borrow pits generally paralleling the levee for its entire length. Most borrow areas are located riverward of the levee, and will eventually fill with sediments from the Mississippi River. These sediments may be used again to construct or repair a future levee section.

74. Generally, levee borrow pits are shallow depressions which are subject to periodic flooding from the Mississippi River. Borrow pits mimic newly flooded reservoirs in that primary and secondary productivity is very high as indicated by the wide daily fluctuations in dissolved oxygen and pH. The shallow depths bring most of the bottom area into the photic zone, thus making the entire borrow pit basin the equivalent of a littoral zone in a large lake, typically the most biologically productive area in lentic habitats.

75. Based on the method used to initially select borrow pits for sampling, the hydrographic survey maps are an excellent tool for characterizing a large area or reach of river. However, the selection of specific sampling areas based on hydrographic survey data was not practical nor appropriate for this study. There was no correlation, for instance, between the estimated sizes of borrow pits based on the hydrographic survey maps and the actual sizes of the borrow pits measured in the field by using site surveys. The average size of the 25 borrow pits measured on the hydrographic surveys was 10.2 acres per pit, whereas the site surveys confirmed an average size of 19.2 acres. Estimates developed by Ryckman, Edgerley, Tomlinson and Associates (1975), of water filled and dry borrow pits showed that approximately 75 percent of all borrow pits were dry during the low water season, but held water intermittently throughout the year. Experiences with choosing borrow pits for this study confirm those estimates. These observations should be taken into consideration in future studies relying on hydrographic survey maps for sample area site selection.

76. The data describing the physical characteristics of borrow pits are survey in scope and represent the first time a large number of borrow pits representing the entire Lower Mississippi River has been described and compared.

77. There were no particularly strong correlations among physical variables except for some of the more obvious and expected (RM versus controlling elevation, for example). There were others that were artifacts of construction techniques in borrow areas due to regional soil conditions or depth of suitable materials for borrow (i.e., RM versus MBS). However, there were some relationships which could not be explained due to either the method of collection of data, time interval over which the information was collected, lack of samples, the survey scope of the study, or other factors. In particular, it is unclear why average surface temperature and average annual days flooded were positively correlated, or what relationship existed between borrow pits further from the Mississippi River which had greater surface turbidities, than those closer to the river, yet showed a negative correlation with Secchi disc depth. These relationships do not show interdependence, but provide a basis for further investigation.

PART V: CONCLUSIONS

78. The data suggest that borrow pit basins associated with the main-line levees are a source of shallow, productive aquatic habitat with potential significant ecological value, and controlled mainly by flooding from the Mississippi River.

79. Borrow pits represent a valuable, renewable, economical source of borrow material and, in the more shallow pits, potential as agricultural land once the borrow area has been cleared, excavated and drained. The diversity of borrow pit sizes, shapes, and location on the river have been governed by site characteristics and construction needs.

80. Traditional indicators of environmental quality based on morphological characteristics used to describe other lake systems do not generally fit this rather unique system of aquatic basins. The SDI, an index used to indicate the irregularity or sinuosity of a lake shoreline, is not generally applicable to assessing shoreline sinuosity of levee borrow pits. In this study the borrow pits with the higher SDI's were generally narrow, and elongated. Other measurable physical parameters were largely dependent on physical requirements of the levee construction site, sediment type, and characteristics of the borrow materials. Correlation of water quality and sediment variables suggested that larger, deeper borrow pits were more productive. However, the data were confounding in that the larger, deeper borrow pits were located on the lower reaches of the Mississippi River, and the borrow pits with greater concentration of dissolved oxygen and higher pH's, indicating higher productivity, were located in the upper portions of the study area.

REFERENCES

- American Public Health Association. 1980. Standard Methods for the Examination of Water and Wastewater, 15th ed, New York.
- Brezonik, P.L. 1978. "Effect of Organic Color and Turbidity on Secchi Disk Transparency," Journal of the Fisheries Research Board of Canada, Vol 35, pp 1410-1416.
- Cobb, S. P., Clark, J. R. 1981. "Aquatic Habitat Studies on the Lower Mississippi River, River Mile 480 to 530; Report 2: Aquatic Habitat Mapping," Miscellaneous Paper E-80-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Cobb, S. P., Pennington, C. H., Baker, J.A., and Scott, J. E. 1984. "Lower Mississippi River Environmental Program, Report 1: Fishery and Ecological Investigations of Main Stem Levee Borrow Pits Along the Lower Mississippi River," US Army Engineer Mississippi River Commission, Vicksburg, Miss.
- Department of the Army, Corps of Engineers. 1970. "Engineer Manual for Laboratory Soil Testing," EM 1110-2-1906, Washington, DC.
- Department of the Army, Corps of Engineers. 1978. "Design and Construction of Levees", EM 1110-2-1913, Washington, DC.
- Elliott, D. O. 1932. "The Improvement of the Lower Mississippi River for Flood Control and Navigation," US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
- Harrison, R. W. 1950. "Levee Building in Mississippi Before the Civil War", The Journal of Mississippi History, Vol 12, pp 63-97.
- Hewson, W. 1860. Principles and Practices of Embanking Lands from River-Floods as Applied to Levees of the Mississippi, D. Van Nostrand, New York.
- Hutchinson, G. E. 1957. A Treatise on Limnology, John Wiley and Sons, New York.
- Jackson, T. H. 1931. Seepage in Mississippi River Levees, XVth International Congress of Navigation, Permanent International Association of Navigation Congresses, Venice, Italy.
- Landin, M. C. 1985. "Bird and Mammal Use of Selected Lower Mississippi River Borrow Pits." Ph.D. thesis, Mississippi State University, Mississippi State, Miss.
- Keown, M. P., Dardeau, E. A., Jr., and Causey, E. M. 1981. "Characterization of the Suspended-Sediment Regime and Bed-Material Gradation of the Mississippi River Basin; Report 1, Volumes 1 and 2, Potamology Program," US Army Engineer District, New Orleans, La.

- Mortimer, C. H. 1969. "Physical Factors with Bearing on Eutrophication in Lakes in General and in Large Lakes in Particular," Eutrophication: Causes, Consequences, Correctives, Proceedings of a Symposium, National Academy of Sciences, Washington, DC, pp 340-368.
- Ryckman, Edgerley, Tomlinson and Associates. 1975. "Environmental Assessment of the Mississippi River and Tributaries Project, Cairo, Illinois to Venice, Louisiana," US Army Engineer Division, Lower Mississippi Valley, Vicksburg, Miss.
- US Army Corps of Engineers, Mississippi River Commission. 1947. Code for Utilization of Soils Data for Levees, Vicksburg, Miss.
- US Army Corps of Engineers, Mississippi River Commission. 1976. Mississippi River and Tributaries, Mississippi River Levees and Channel Improvement, Final Environmental Impact Statement, US Army Engineer District, Vicksburg, Miss.
- Welch, P. S. 1948. Limnological Methods, McGraw-Hill, New York.
- Wetzel, R. G., and Likens, G. E. 1979. Limnological Analysis, W. B. Saunders Co., Philadelphia, Pa.

Table 1

Twenty Mile Test Reaches Used for Initial Borrow Pit Characterization,
Based on 1976 Comprehensive Hydrographic Survey Maps
of the Lower Mississippi River

<u>Site Name</u>	<u>River Miles</u>	<u>Number of Pits</u>	<u>Average Surface Acres</u>	<u>Average Shoreline Length feet</u>	<u>Average Estimated SDI</u>	<u>Average Nearness to River miles</u>
New Madrid, Md. Range	880-900	17	7.6 2.0-33.0	7,610 2,640-2,120	3.8 2.0-7.1	1.0 0.5-1.5
Osceola, Ark. Range	775-795	6	6.1 2.0-18.0	10,640 3,325-36,960	5.0 2.2-11.7	1.7 1.2-2.6
Helena, Ark. Range	635-655	32	9.4 2.0-58.0	10,140 3,960-33,685	4.6 3.1-8.7	1.4 0.4-2.6
Rosedale, Miss. Range	580-600	23	9.3 3.0-42.0	11,205 4,645-28,405	5.0 3.3-7.9	2.0 0.4-4.8
Vicksburg, Miss. Range	455-475	43	7.8 1.5-49.0	9,415 2,005-33,420	4.7 2.2-8.2	1.3 0.3-3.2
Natchez, Miss. Range	340-360	23	13.1 2.0-47.0	16,495 2,640-40,920	6.2 2.5-10.3	2.4 0.3-5.9
Tunica Bend, La. Range	285-305	32	8.1 1.0-32.0	12,755 1,320-46,885	5.9 1.8-13.1	3.4 0.5-6.6
Donaldsonville, La. Range	175-195	26	5.3 1.0-22.0	12,325 2,640-39,600	7.0 3.5-11.5	0.3 0.2-1.0
Port Sulfur, La. Range	30-50	11	16.8 2.9-94.0	17,890 5,280-46,885	6.0 3.3-10.0	0.3 0.2-0.4

NOTE:

Total river miles	= 180
Total borrow pits	= 213
Total acres of borrow pits	= 2,165
Average borrow pit size (acres)	= 10.2
Total shoreline length (feet)	= 2,457,785
Average shoreline length (feet)	= 11,535
Average SDI	= 5.3
Average nearness to river (miles)	= 1.8

Table 2

Location of 25 Study Borrow Pits on the Lower Mississippi River

<u>Pit No.</u>	<u>River Mile</u>	<u>Parish/County</u>	<u>State</u>
1	431	Madison	Louisiana
2	407	Tensas	Louisiana
3	469	East Carroll	Louisiana
4	482	East Carroll	Louisiana
5	462	East Carroll	Louisiana
6	433	Madison	Louisiana
7	460	Warren	Mississippi
8	593	Bolivar	Mississippi
9	595	Bolivar	Mississippi
10	456	Madison	Louisiana
11	602	Bolivar	Mississippi
12	377	Concordia/Tensas	Louisiana
13	656	Phillips	Arkansas
14	584	Desha	Arkansas
15	659	Coahoma	Mississippi
16	355	Concordia	Louisiana
17	733	Mississippi	Arkansas
18	323	Concordia	Louisiana
19	877	New Madrid	Missouri
20	305	Concordia	Louisiana
21	881	New Madrid	Missouri
22	315	Concordia	Louisiana
23	720	Shelby	Tennessee
24	151	St. James	Louisiana
25	180	Ascension	Louisiana

Table 3

Hydrologic, Morphometric, and Location Data for 25 Borrow Pits Along the Main Stem
Levee System of the Lower Mississippi River Arranged by Descending River Mile

River Mile	Borrow Pit Number	Surface Area acres	Mean Depth feet	Maximum Depth feet	Shoreline Length feet	Shoreline Development Index	Volume cubic yards	Volume Development Index	Mean Basin Slope percent	Controlling Elevation feet, NGVD	Distance to River miles	Average Annual Days Flooded
881.R *	21	9.2	1.7	3.5	4,545	2.0	23,167	1.5	0.02	287.0	2.5	24
877.R	19	7.4	0.5	1.1	4,090	2.0	6,479	1.5	0.01	279.1	0.8	63
773.R	17	34.1	3.0	5.7	10,498	2.3	183,100	1.6	0.03	235.0	2.3	25
720.L **	23	17.7	2.8	6.2	7,851	2.5	76,025	1.4	0.03	195.0	1.0	115
659.L	15	53.4	3.9	7.5	8,881	1.6	348,228	1.6	0.02	173.0	1.8	56
656.R	13	53.4	3.9	16.9	14,008	2.6	309,178	0.7	0.05	171.0	0.3	56
602.L	11	4.3	9.6	1.6	4,372	2.8	4,056	1.1	0.03	143.7	2.1	98
595.L	9	3.3	1.7	3.5	1,916	1.4	9,780	1.5	0.03	137.2	1.1	84
593.L	8	16.2	2.2	4.2	5,802	2.0	61,516	1.6	0.02	139.8	0.3	98
584.R	14	47.7	2.9	5.5	15,064	3.0	224,106	1.6	0.02	137.0	4.3	89
482.R	4	32.1	2.0	4.5	9,531	2.3	100,102	1.3	0.02	90.5	0.4	84
469.R	3	39.6	2.6	8.2	5,472	1.2	153,090	0.9	0.02	89.0	0.4	84
462.R	5	12.7	1.5	2.7	4,055	1.5	29,186	1.6	0.01	84.0	0.6	84
460.L	7	5.2	2.0	4.5	2,761	1.6	18,215	1.7	0.03	79.8	0.9	111
456.R	10	9.1	2.6	4.8	3,441	1.6	45,495	1.7	0.03	81.6	0.1	104
433.R	6	4.5	3.8	6.0	5,737	3.7	6,241	1.9	0.10	79.8	1.3	89
431.R	1	13.9	6.6	11.1	4,408	1.6	133,857	1.8	0.06	73.0	0.3	84
407.R	2	18.7	5.7	10.4	4,440	1.5	178,733	1.6	0.05	68.8	2.4	71
377.R	12	9.3	2.1	4.0	3,786	1.7	29,973	1.6	0.02	55.0	0.7	84
355.R	16	7.4	1.4	3.0	3,618	1.8	18,091	1.4	0.02	49.1	0.2	84
323.R	18	3.3	2.2	5.1	3,559	2.6	10,779	1.3	0.05	41.8	1.8	84
315.R	22	6.7	7.2	17.7	4,947	2.6	71,813	1.2	0.14	47.0	0.4	65
305.R	20	6.8	4.4	7.7	2,580	1.3	51,313	1.8	0.05	40.0	0.3	99
180.L	25	36.9	5.6	10.3	15,225	3.4	325,348	1.6	0.07	21.0	0.1	81
151.L	24	22.1	4.3	7.5	10,796	3.1	149,314	1.7	0.06	14.0	0.1	117
Total		479.0	78.2	163.2	161,783	53.7	2,567,185	37.2	0.99		26.5	2,033
Mean		19.2	3.1	6.5	6,471	2.2	102,687	1.5	0.04		1.1	81.3
Median		11.0	2.7	5.3	4,693	2.0	48,404	1.6	0.03		0.65	84
Range low		3.3	0.5	1.1	1,916	1.2	4,056	0.7	0.01		0.1	24
Range high		53.4	7.7	17.7	15,225	3.7	348,228	1.9	0.14		4.3	117
Standard deviation low			1.8	4.1	3,641	0.7	106,288	0.3	0.03		1.04	23.5

* Indicates right bank.

** Indicates left bank.

Table 4

[illegible]

Table 5
Summary Sediment Data from 25 Borrow Pits
along the Lower Mississippi River

Pit No.	Percent Sediment Passing #230 Mesh Sieve	Range percent	Percent * Volatile Residue	Range percent
1	97.8	95.2 - 99.1	8.7	6.9 - 10.4
2	96.9	94.1 - 98.6	6.0	2.9 - 7.4
3	87.6	72.1 - 96.0	3.4	1.9 - 5.4
4	96.6	88.3 - 99.5	6.9	2.8 - 8.9
5	99.6	99.5 - 99.8	5.9	3.0 - 7.2
6	94.4	79.5 - 99.3	6.1	0.9 - 8.2
7	98.6	95.8 - 99.4	8.5	5.7 - 12.0
8	81.7	42.8 - 97.3	5.4	2.8 - 7.3
9	97.1	92.9 - 99.5	8.3	7.0 - 10.1
10	67.2	24.6 - 98.3	4.2	1.0 - 6.7
11	99.5	98.7 - 99.9	5.8	4.7 - 6.3
12	85.8	57.9 - 99.2	5.1	2.8 - 6.6
13	54.6	17.7 - 82.3	4.0	1.2 - 5.4
14	80.5	29.5 - 99.0	6.0	1.2 - 9.6
15	72.9	57.6 - 90.6	10.0	4.6 - 18.4
16	75.1	45.5 - 88.3	4.1	2.0 - 5.2
17	92.4	82.6 - 97.4	6.9	5.5 - 10.0
18	98.8	97.7 - 99.6	6.0	5.4 - 6.8
19	90.0	67.3 - 99.3	5.5	4.7 - 6.4
20	95.9	90.3 - 99.2	4.7	3.1 - 6.3
21	67.4	45.5 - 99.0	5.1	3.2 - 8.6
22	95.3	89.5 - 99.4	3.9	2.8 - 5.0
23	97.0	86.5 - 99.8	5.0	4.3 - 5.9
24	99.1	98.5 - 99.6	4.5	3.3 - 5.0
25	97.0	92.4 - 99.1	3.6	2.5 - 4.4
Average	88.8		5.7	

* Average of six samples.

Table 6
Annual Flooding Data from 25 Borrow Pits
Along the Lower Mississippi River

<u>Year</u>	<u>Days Flooded Average</u>	<u>Days Flooded Percent of Year</u>	<u>Annual High</u>		<u>Annual Low</u>	
			<u>Pit No.</u>	<u>Days</u>	<u>Pit No.</u>	<u>Days</u>
1973	182	50	24	220	17	68
1974	154	42	7	187	21	28
1975	121	33	24	161	21	36
1976	19	5	23	70	2,13,15 17,21,22	0
1977	14	4	23	69	2,13,15 17,21	0
1978	68	19	23	113	17	16
1979	117	32	24	174	21	57
1980	40	11	24	53	21	11
1981	16	4	23	50	2,13,15 17,21,22	0

Table 7
Correlation Matrix for Physical and Physico/Chemical Data
for 25 Borrow Pits Along the Lower Mississippi River

	River Mile	Surface Area	Mean Depth	Maximum Depth	Shoreline Length	Shoreline Development Index	Volume	Mean Basin Slope	Controlling Elevation	Distance to River	Average Annual Days Flooded
Temperature	0.21	0.33	-0.06	0.01	0.15	0.01	0.25	-0.06	0.25	0.04	-0.46
DO	0.53	0.30	-0.13	0.09	0.19	-0.13	0.11	-0.18	0.50	-0.01	-0.24
DO saturation	0.53	0.32	-0.13	0.10	0.21	-0.12	0.13	0.17	0.50	-0.01	-0.28
Median pH	0.42	0.20	-0.23	-0.04	0.17	0.02	0.05	-0.20	0.41	0.07	-0.16
Average ORP	0.26	0.16	0.22	0.20	0.11	-0.08	0.18	0.07	0.31	-0.20	-0.20
Conductivity	-0.09	-0.20	-0.28	-0.26	-0.11	0.18	-0.18	-0.08	-0.07	-0.14	0.21
Turbidity (n = 24)	0.29	-0.19	-0.17	-0.28	-0.14	-0.11	-0.23	-0.24	0.32	0.54	-0.19
Percent volatile residue	0.27	0.04	-0.04	-0.23	-0.16	-0.25	0.05	-0.21	0.20	0.32	-0.10
Secchi disc	-0.14	0.34	0.46	0.60	0.14	-0.03	0.35	0.38	-0.16	-0.35	-0.03
Percent silt-clay	-0.39	-0.40	0.14	-0.14	-0.23	0.11	-0.31	0.25	-0.38	-0.05	0.39

Table 8

Correlation Matrix for Physico/Chemical Data

for 25 Borrow Pits along the Lower Mississippi River

[illegible]

APPENDIX A:

BORROW PIT PHYSICAL CHARACTERIZATION DATA

APPENDIX A

Definition of Terms and Units of Measure Used in Appendix A

Bank	Bank of river either left (L) or right (R) looking downstream
Maximum Depth	Feet
Control Elevation	Elevation, relative to National Geodetic Vertical Datum (NGVD)
Shoreline Length	Feet
Relative Location	Determined from hydrographic surveys, borrow pits were described as on straight, or either concave or convex river reaches and was based on the shortest line drawn perpendicular to the navigation line in the main channel, intersecting the borrow pit. If the river channel curved away from the borrow pit, the description was "convex". If the river channel curved into the borrow pit, the description was "concave". No curvature was described as "straight".
River Mile (RM)	Mississippi River Nautical River Mile based on 1976 Hydrographic Survey
Volume	Cubic yards
Mean Depth	Feet
Surface Area	Acres
Mean Basin Slope (MBS)	Percent slope
Nearness to River	Miles
Contour Interval	Elevation of contour, NGVD
Length of Upper Contour	Feet
Slope Between Contours	Percent slope
DO	Dissolved oxygen, mg/l
DO Saturation	Percent saturation
pH	pH units
ORP	Oxidation - reduction Potential, millivolt

(Continued)

Definition of Terms and Units of Measure Used in Appendix A (Concluded)

Conductivity	micromhos/cm
Temperature	Degrees centigrade
Turbidity	Nephelometric turbidity unit (NTU)
Secchi Disc	Metres
Sediment % V.R.	Percent volatile residue

Sediment Analysis

US Mesh	Standard Sieves Description	Seive Opening		Wentworth Scale		
		mm	in.	mm	Scale	Description
3		6.35	0.25			
4	Fine Gravel	4.76	0.187	4	4	Granule
6		3.36	0.132			
10	Coarse Sand	2.00	0.079	2	2	Very Coarse Sand
16		1.19	0.047	1	1	Coarse Sand
20		0.84	0.033			
30		0.59	0.023			
40	Medium Sand	0.42	0.0165	1/2	0.5	Medium Sand
50		0.297	0.0117			
70		0.210	0.0083	1/4	0.250	Fine Sand
100		0.149	0.0059			
140		0.105	0.0041	1/8	0.125	Very Fine Sand
200	Fine Sand	0.074	0.0029			
230	Silt-Clay	0.062	0.0024	1/16	0.062	Silt

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>1</u>	River Mile	<u>431</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>133,857</u>	Shore Development Index	<u>1.6</u>
Max. Depth	<u>11.1</u>	Mean Depth	<u>6.6</u>	Mean Basin Slope	<u>0.06</u>
Control Elevation	<u>73.0</u>	Surface Area	<u>13.9</u>	Volume Development Index	<u>1.8</u>
Shoreline Length	<u>4408</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>0.3</u>
Relative Location	<u>Concave</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	72.0-73.0	0.846	4407.6	0.12
74	170	47	71.0-72.0	1.001	4551.0	0.10
75	128	35	70.0-71.0	1.000	4489.1	0.11
76	18	5	69.0-70.0	1.089	4610.5	0.09
77	5	1	68.0-69.0	0.866	4335.6	0.11
78	68	19	67.0-68.0	0.815	4241.5	0.12
79	114	31	66.0-67.0	1.651	4210.9	0.06
80	41	11	65.0-66.0	2.471	3684.1	0.03
81	10	3	64.0-65.0	2.804	3648.0	0.02
			63.0-64.0	1.231	1778.2	0.02
			62.0-63.0	0.113	366.4	0.06
			62.0-Below	0.034	174.2	

Date Sampled: 10 June 1981 Time Sampled: 1000

Water Quality Data, Surface

Parameter	<u>Location</u>						
	<u>Leveeward</u>		<u>Open Water</u>		<u>Riverward</u>		
	<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>	<u>X̄</u>
DO	4.5	5.9	6.5	6.8	6.7	7.2	6.3
DO Saturation	58	75	83	86	86	92	80
pH	8.0	7.8	8.3	8.2	8.4	8.3	
ORP	310	310	300	300	310	300	305
Conductivity	360	360	355	355	330	360	353
Temperature	23.0	22.5	29.0	28.0	29.0	29.0	28.7
Turbidity			10.0	10.0			10.0
Secchi Disc	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Sediment Percent V.R.	6.9	8.9	7.3	9.0	9.7	10.4	8.7

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 1

Water Quality Data, Subsurface

<u>Location/Parameter</u>	<u>Depth</u>	<u>DO</u>		<u>pH</u>	<u>ORP</u>	<u>Cond.</u>	<u>Temp.</u>
		<u>DO</u>	<u>Saturation</u>				
A2	2.0	4.1	52	7.9	310	360	28.5
A3	2.4	5.0	64	7.9	310	340	28.5
B1	2.0	4.0	51	7.8	315	360	28.5
B2	2.0	1.4	16	7.6	315	355	27.5

Grain Size Analysis

<u>Sieve Size</u>	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4			100.0			100.0
6			99.7		100.0	99.7
10			99.6		99.6	99.2
16			99.4		99.2	98.9
20			99.3		99.2	98.8
30			99.1	100.0	99.2	98.5
40			99.1	99.8	99.2	98.3
50			99.0	99.6	99.2	98.0
70	100.0		98.9	99.4	98.8	97.5
100	99.7	100.0	98.7	99.2	98.8	97.2
140	99.5	99.5	98.4	99.2	98.8	96.4
200	98.6	99.1	98.0	98.8	98.3	95.6
230	97.8	99.1	97.9	98.6	98.3	95.2

Narrative Description of Borrow Pit 1

Borrow Pit 1 is located in Madison Parish, Louisiana, on the right bank of the Mississippi River at RM 431. The southern end of the borrow pit is approximately 3,500 feet from the bank of the Mississippi River, while the northern end is about 5,000 feet. The pit is located on a concave bend and is positioned to the west of Racetrack Towhead which is located parallel to Reid Bedford Bend. The borrow pit is one in a series of pits separated by traverses. During high water, the borrow pit is confluent with adjacent pits. The borrow pit is 13.9 acres in surface area and has a total shoreline length of 4,408 feet. Borrow Pit 1 is 11.1 feet deep with a mean depth of 6.6 feet. The borrow pit has two islands that are located within the pooled area of the borrow pit.

Terrestrial vegetation on the levee side of the borrow pit is a mixed of Johnson grass and Bermuda grass pasture, while the river side exhibits typical marsh vegetation and bottomland hardwood characteristics of the Mississippi River batture lands. In and near the shallow areas of the pit on the riverside, buttonbush, swamp privet and rose mallow are common, while black willow, bald cypress, cottonwood, box elder, bitter pecan, American elm, sycamore, and ash tend to be located on the high ground towards the river.

The bankline of the borrow pit is somewhat regular with a SDI of 1.6, which is less than the average SDI of all borrow pits (SDI = 2.2). The slope of the bottom is greater for the first six feet of contour than most other borrow pits, with an average slope of 0.09 percent. The slope of the remaining bottom area, however, is low (0.04 percent) which is equal to the mean basin slope for all borrow pits. Bottom sediments tend to contain more organic matter and are more coarse and sandy riverward and downstream as compared with the leveeward, upstream margin. Borrow Pit 1 was flooded an average of 84 days per year which compares reasonably well with the average 81 days per year for all borrow pits. The pit floods every year, even during low runoff years.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>2</u>	River Mile	<u>407</u>	Percent Days Flooded	<u>19</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>178,733</u>	Shore Development Index	<u>1.5</u>
Max. Depth	<u>10.4</u>	Mean Depth	<u>5.7</u>	Mean Basin Slope	<u>0.05</u>
Control Elevation	<u>68.8</u>	Surface Area	<u>18.7</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>4840</u>	Average Days Flooded	<u>71</u>	Nearness to River	<u>2.4</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	182	50	68.0-68.8	1.124	4839.5	0.08
74	157	43	67.0-68.0	1.554	4795.4	0.07
75	113	31	66.0-67.0	1.429	4675.6	0.07
76	0	0	65.0-66.0	1.255	4536.1	0.08
77	0	0	64.0-65.0	1.075	4405.3	0.09
78	47	13	63.0-64.0	1.249	4351.8	0.08
79	101	18	62.0-63.0	1.336	4294.1	0.07
80	37	10	61.0-62.0	3.322	4269.9	0.03
81	0	0	60.0-61.0	2.316	3673.0	0.03
			59.0-60.0	2.622	2851.7	0.02
			59.0-Below	1.363	1773.0	

Date Sampled: 16 June 1981

Time Sampled: 1330

Water Quality Data, Surface

Parameter	<u>Location</u>						<u>X</u>
	<u>Leveeward</u>		<u>Open Water</u>		<u>Riverward</u>		
	<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>	
DO	8.3	6.1	7.1	2.4	7.3	2.3	5.6
DO Saturation	114	82	97	32	99	31	76
pH	8.7	8.2	8.5	7.3	8.5	7.3	
ORP	229		200				215
Conductivity	210	200	220	200	200	200	205
Temperature	33.0	32.0	32.5	31.0	32.5	31.0	32.0
Turbidity			47.0	37.0			42.0
Secchi Disc	0.1	0.2	0.1	0.2	0.2	0.2	0.2
Sediment Percent V.R.	2.9	7.3	7.4	5.1	6.2	6.8	6.0

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 2

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6					100.0	
10					99.8	
16	100.0				99.6	
20	99.8			100.0	99.6	
30	99.7			99.9	99.5	
40	99.5	100.0	100.0	99.7	99.3	
50	99.2	99.9	99.9	99.6	99.1	100.0
70	98.2	99.7	99.8	99.1	98.9	99.8
100	97.8	99.5	99.5	98.5	98.9	99.6
140	97.4	98.9	99.0	98.0	98.7	99.4
200	95.8	98.4	97.8	96.9	98.2	99.0
230	94.1	97.9	96.9	96.2	97.5	98.6

Narrative Description of Borrow Pit 2

Borrow Pit 2 is located in Tensas Parish, Louisiana, on the right bank of the Mississippi River at RM 407. The borrow pit is equidistant between Yucatan Lake to the north and Old River Lake to the south and is adjacent to the mainline levee at Levee Station 5350. The borrow pit is approximately 2.4 miles from the main channel, and is the northern terminus of a series of borrow pits separated by traverses. Borrow Pit 2 is not connected to any other borrow pit to the north, and it gradually grades from a pooled condition on the southern end to a fast-land on the northern end. The borrow pit is 18.7 acres in surface area and has a total shoreline length of 4,840 feet. Borrow Pit 2 is 10.4 feet deep with a mean depth of 5.7 feet.

Trees, mainly black willow, Eastern cottonwood, and American sycamore are present along the shoreline of the borrow pit for most of its perimeter, but are scattered. Johnson grass and Bermuda grass comprise the most common levee grasses, while swamp privet and rose mallow is found near the shallow, sloping northern end of the borrow pit. The swamp privet and rose mallow give way to annual elder and common ragweed on the fast-land. Understory is generally dense and comprised of numerous vines and herbaceous cover.

The bankline of the borrow pit is somewhat regular with an SDI of 1.5 as compared with the average SDI for all pits of 2.2. Mean basin slope is 0.05 percent, a little greater than the average for all borrow pits of 0.04 percent. The bank slope is 0.07 percent for the first 5.8 feet of depth in the borrow pit, as compared with the mean basin slope of 0.03 percent for the remaining five feet of depth.

In Borrow Pit 2, there is a tendency for lower sediment grain size toward the river. Percent volatile matter does not show a consistent pattern. Borrow Pit 2 does not flood every year, and floods on the average of 71 days per year compared with an overall borrow pit average of 81 days per year.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>3</u>	River Mile	<u>469</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>153,090</u>	Shore Development Index	<u>1.2</u>
Max. Depth	<u>8.2</u>	Mean Depth	<u>2.6</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>89</u>	Surface Area	<u>39.6</u>	Volume Development Index	<u>0.9</u>
Shoreline Length	<u>5472</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>0.4</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	88.0-89.0	3.571	5471.6	0.04
74	170	47	87.0-88.0	11.392	5582.8	0.01
75	128	35	86.0-87.0	13.705	8184.1	0.01
76	18	5	85.0-86.0	8.787	4608.5	0.01
77	5	1	84.0-85.0	1.316	4024.1	0.06
78	63	19	83.0-84.0	0.446	2716.8	0.16
79	114	31	82.0-83.0	0.323	3627.7	0.15
80	41	11	81.0-82.0	0.068	446.4	0.09
81	10	3	81.0-Below	0.001	55.2	

Date Sampled: 6 June 1981

Time Sampled: 1530

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		X
	A	B	A	B	A	B	
DO	9.7	8.5	8.9	9.8	9.3	9.5	9.3
DO Saturation	129	112	119	132	127	130	125
pH	8.6	8.6	8.5	8.6	8.6	8.6	
ORP	275	265	275	260	265	260	267
Conductivity	310	310	315	315	320	320	315
Temperature	31.0	30.0	31.0	32.0	33.0	33.0	31.7
Turbidity			10.0				
Secchi Disc	0.5	0.6	0.5	0.7	0.5	0.5	0.6
Sediment Percent V.R.	3.1	4.7	5.4	2.0	1.9		3.4

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 3

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6						
10		100.0	100.0		100.0	No Sample
16		99.9	99.8		99.9	No Sample
20		99.9	99.7		99.9	No Sample
30	100.0	99.9	99.5	100.0	99.8	No Sample
40	99.9	99.8	98.5	99.9	99.7	No Sample
50	99.9	99.6	95.6	99.9	99.3	No Sample
70	99.8	99.2	92.5	99.8	96.8	No Sample
100	99.7	98.3	87.9	99.4	94.7	No Sample
140	99.4	97.5	82.9	98.8	91.6	No Sample
200	97.6	95.5	75.8	97.2	84.7	No Sample
230	95.5	94.2	72.1	96.0	80.4	No Sample

Narrative Description of Borrow Pit 3

Borrow Pit 3 is located in East Carroll Parish, Louisiana, on the right bank of the Mississippi River at RM 469. The pit is west of Cottonwood Bar on Island No. 97, 1,000 feet from the Mississippi River Channel with the southern end adjacent to Levee Station 1750. The borrow pit was excavated in 1981 and flooded that first year. As originally constructed, the pit had traverses at the northern and southern ends, however, culverts were added in 1981/1982 to drain the borrow pit and reclaim the land to agriculture. The borrow pit is 39.6 acres in total surface area with a shoreline length of 5,472 feet. Borrow Pit 3 has a maximum depth of 8.2 feet and a mean depth of 2.6 feet.

The surrounding land is used exclusively for agriculture. Vegetation immediately surrounding the pit consists of perennial rye that had been planted to stabilize the adjacent newly constructed levee slope.

The bank line of the new borrow pit indicated an SDI of 1.2, somewhat lower than the average SDI of 2.2 for all borrow pits, even with the presence of two islands in the pit. The borrow pit's mean basin slope was 0.02 percent, which was reflected in the pit's flat basin and very gently sloping banks. There is a trend to more coarse sediments moving from the levee to the riverside of the borrow pit, with no trend of volatile or carbonaceous material noted. Although the borrow pit was constructed in 1981, subsequent flooding by the Mississippi River established a fish population in the pit which was subsequently sampled during the biological studies. Historically, this area could be expected to flood every year. Average flooding for this pit was 84 days which matched the average days flooded for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>4</u>	River Mile	<u>482</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>100,102</u>	Shore Development Index	<u>2.3</u>
Max. Depth	<u>4.5</u>	Mean Depth	<u>2.0</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>90.5</u>	Surface Area	<u>32.1</u>	Volume Development Index	<u>1.3</u>
Shoreline Length	<u>9531</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>0.4</u>
Relative Location	<u>Concave</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	90.0-90.5	4.997	9531.2	0.02
74	170	47	89.0-90.0	8.069	9231.9	0.02
75	128	35	88.0-89.0	7.221	7433.9	0.02
76	18	5	87.0-88.0	6.335	6084.1	0.02
77	5	1	87.0-Below	5.509	4068.7	
78	68	19				
79	114	31				
80	41	11				
81	10	3				

Date Sampled: 19 June 1981

Time Sampled: 1730

Water Quality Data, Surface

Parameter	Location						
	Leveeward		Open Water		Riverward		\bar{X}
	A	B	A	B	A	B	
DO	9.0	12.4	8.6	11.0	8.4	11.4	10.1
DO Saturation	122	173	116	153	112	157	139
pH	8.3	8.7	8.3	8.6	8.4	8.6	
ORP	289	280	285	270	290	285	283
Conductivity	380	370	370	380	375	362	373
Temperature	32.0	34.5	32.0	34.0	31.0	33.5	32.8
Turbidity			18.0	17.0			17.5
Secchi Disc	0.2	0.3	0.2	0.3	0.3	0.3	0.3
Sediment Percent V.R.	7.4	2.8	7.4	5.9	8.8	8.9	5.9

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 4

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
0.4				100.0		
3				97.6		
4		100.0		96.0		
6		99.6		95.6		
10		99.2		95.3	100.0	
16		99.0		94.9	99.9	
20		98.8		94.7	99.8	
30		98.8		94.7	99.8	
40	100.0	98.6		94.7	99.8	
50	99.9	98.6		94.5	99.8	
70	99.7	98.4	100.0	94.4	99.7	
100	99.6	98.2	99.8	94.2	99.7	100.0
140	99.1	98.0	99.5	93.7	99.6	99.8
200	98.1	97.6	99.2	90.6	98.8	99.7
230	97.3	97.2	98.9	88.3	98.1	99.5

Narrative Description of Borrow Pit 4

Borrow Pit 4 is located in East Carroll Parish, Louisiana, on the right bank of the Mississippi River at RM 482. The borrow pit lies immediately east of the Hollybrook Crevasse and adjacent to the levee at Levee Station 1300. The borrow pit is located on a concave river bend and has borrow pits adjoining the east and west ends. Borrow Pit 4 is 0.4 miles from the Mississippi River. It has a total surface area of 32.1 acres and a shoreline length of 9,531 feet. The maximum depth of the borrow pit is 4.5 feet with a mean depth of 2.0 feet.

The pit is surrounded on all sides by a fringe of large hardwood trees. A cottonwood plantation adjoins the fringe of hardwood trees which extends to near the river. The western end is somewhat more shallow than the eastern end and supports emergent vegetation such as buttonbush. Snags are common along the margin of the borrow pit. Woody vegetation mainly consists of American sycamore, Eastern cottonwood, green ash, sugarberry, box elder, bald cypress, willow honey locust, slippery elm, overcup oak and bitter pecan. Principle understory is dewberry, peppervine, greenbriers, lady's ear drops, poison ivy, and other vines and shrubs. The leveeside grasses are typically mixed pasture grasses and are generally devoid of herbaceous plants due to grazing pressure.

The shoreline is slightly irregular and exhibits an SDI of 2.3, somewhat greater than the 2.2 average SDI for all borrow pits. The mean basin slope is 0.02 percent and does not vary between borrow pit contours.

Sediments are more coarse in the center of the borrow pit than on either bank. On the eastern end, sediments are coarse near the levee and grade to very fine riverward. Volatile matter is constant with cross section on the western end of the borrow pit. On the eastern end, however, volatile matter near the levee is very low, with very high percentages in the center and riverward. Borrow Pit 4 floods yearly, and averages 84 days per year, which equals the average days flooded for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>5</u>	River Mile	<u>462</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>29.186</u>	Shore Development Index	<u>1.5</u>
Max. Depth	<u>2.7</u>	Mean Depth	<u>1.5</u>	Mean Basin Slope	<u>0.01</u>
Control Elevation	<u>84.0</u>	Surface Area	<u>12.7</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>4055</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>0.6</u>
Relative Location	<u>Convex</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	83.0-84.0	1.823	4054.5	0.05
74	170	47	82.0-83.0	9.317	4501.7	0.01
75	128	35	82.0-Below	1.601	1797.0	
76	18	5				
77	5	1				
78	68	19				
79	114	31				
80	41	11				
81	10	3				

Date Sampled: 17 June 1981 Time Sampled: 1315

Water Quality Data, Surface

Parameter	Location						
	Leveeward		Open Water		Riverward		\bar{X}
	A	B	A	B	A	B	
DO	6.2	5.2	6.3	5.2	6.2	5.3	5.7
DO Saturation	86	72	89	72	87	75	80
pH	8.7	8.4	8.7	8.3	8.7	8.4	
ORP	190	200	180	210	180	210	195
Conductivity	240	240	240	240	240	240	240
Temperature	34.0	34.0	35.0	34.0	35.0	35.0	34.5
Turbidity							
Secchi Disc	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sediment Percent V.R.	6.7	3.0	5.7	6.1	7.2	6.9	5.9

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 5

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6						
10						100.0
16						99.9
20	100.0					99.8
30	99.9			100.0		99.8
40	99.8			99.9		99.7
50	99.7			99.8	100.0	99.7
70	99.7			99.8	99.9	99.7
100	99.7	100.0	100.0	99.7	99.8	99.6
140	99.6	99.9	99.9	99.7	99.7	99.6
200	99.5	99.8	99.8	99.5	99.7	99.6
230	99.5	99.8	99.6	99.5	99.6	99.5

Narrative Description of Borrow Pit 5

Borrow Pit 5 is located in East Carroll Parish, Louisiana, on the right bank of the Mississippi River at RM 462. The borrow pit is adjacent to Willow Cut-Off, southwest of Willow Cut-Off Dike and is approximately 0.6 miles from the Mississippi River. The pit parallels the levee immediately south of Levee Station 2150. The borrow pit is located on a convex or inside river bend and is flanked on three sides by eight other borrow pits. Surrounding this group of borrow pits on two sides is a spur levee, thus this grouping of nine borrow pits is surrounded on three sides by levee. Traverses separate the borrow pits; however, during high water the pits are confluent with one another. The pits also drain into each other at various elevations. Borrow Pit 5 has been observed to completely dry up during the late summer and fall. Borrow Pit 5 has a total surface area of 12.7 acres with a shoreline length of 4,055 feet. The maximum depth of the borrow pit is 2.7 feet with a mean depth of 1.5 feet.

A fringe of woody vegetation borders the eastern edge of the borrow pit, with the majority of vegetation being black willow and an occasional sugar-berry, rose mallows, buttonbush, swamp privet, persimmon, green ash, honey locust, pecan, and Nuttall oak. Grasses and herbaceous plants are heavily grazed, thus, little herbaceous growth is found leveeward and grass is almost entirely Bermuda. The small peninsula and two islands in the pit support black willow and sparse herbaceous growth.

Even with the small peninsula extending to near the center of the borrow pit and the presence of two small islands, calculated SDI was low, 1.5, as compared with the SDI for all pits of 2.2. The mean basin slope is 0.01 percent which reflects the shallow condition of this borrow pit. Sediment grain size indicated no discernable distribution pattern in the borrow pit. The 99.5 percent of sediment in this borrow pit was silt-clay. Organic matter was slightly higher riverward as compared with the leveeside samples. Flooding in Borrow Pit 5 averages 84 days per year which matches the average days flooded for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>6</u>	River Mile	<u>433</u>	Percent Days Flooded	<u>24</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>6241</u>	Shore Development Index	<u>3.7</u>
Max. Depth	<u>6.0</u>	Mean Depth	<u>3.8</u>	Mean Basin Slope	<u>0.10</u>
Control Elevation	<u>79.8</u>	Surface Area	<u>4.5</u>	Volume Development Index	<u>1.9</u>
Shoreline Length	<u>5737</u>	Average Days Flooded	<u>89</u>	Nearness to River	<u>1.3</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	204	56	79.0-79.8	0.196	5736.6	0.52
74	175	48	78.0-79.0	0.719	5303.3	0.17
75	135	37	77.0-78.0	0.687	5245.6	0.10
76	19	5	76.0-77.0	0.712	3711.4	0.12
77	8	2	75.0-76.0	0.839	3398.5	0.09
78	76	21	74.0-75.0	1.350	3155.7	0.03
79	118	32	73.0-Below	0.032	369.0	
80	43	12				
81	19	5				

Date Sampled: 23 June 1981 Time Sampled: 0930

Water Quality Data, Surface

Parameter	Location						\bar{X}
	Leveeward		Open Water		Riverward		
	A	B	A	B	A	B	
DO	5.0	3.1	4.6	4.4	4.0	4.1	4.2
DO Saturation	67	41	62	59	54	56	57
pH	7.6	7.5	7.6	7.7	7.5	7.6	
ORP	300	295	290	300	310	295	298
Conductivity	340	345	340	340	345	340	342
Temperature	31.5	31.0	32.0	32.0	32.0	32.5	31.8
Turbidity			18.0	19.0			18.5
Secchi Disc	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sediment Percent V.R.	5.0	8.2	7.2	7.8	7.3	0.9	6.1

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 6

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6	100.0			100.0		
10	99.7			99.9		
16	99.3	100.0		99.7		
20	99.1	99.9		99.4		
30	99.0	99.7		99.1		
40	98.8	99.7		98.8	100.0	
50	98.6	99.6	100.0	98.4	99.9	100.0
70	98.1	99.5	99.9	98.0	99.7	99.8
100	97.4	99.3	99.6	97.4	99.7	99.7
140	94.2	99.0	99.4	96.7	99.6	99.7
200	84.7	98.1	99.0	94.4	99.2	99.3
230	79.5	97.3	98.9	92.8	98.8	99.3

Narrative Description of Borrow Pit 6

Borrow Pit 6 is located in Madison Parish, Louisiana, on the right bank of the Mississippi River at RM 433. The borrow pit is located 2.2 miles south of the Interstate Highway 20 River Bridge, east of Levee Angle Marker 665, and north of Levee Station 3600. The borrow pit is adjacent to the levee and is located 1.3 miles from the main channel. Borrow Pit 6 is flanked on three sides by borrow pits, and all are separated by traverses but are connected to each other by drainage structures. Borrow Pit 6 has a total surface area of 12.7 acres and a shoreline length of 5,737 feet. It is deeper than adjoining pits and tends to remain wet throughout the year. The maximum depth of the borrow pit is 2.7 feet, with a mean depth of 1.5 feet. Two peninsula-like land areas separate Borrow Pit 6 into two sections. Elevation data indicate the two sections may become isolated during low water.

The pit contains two islands on which black willow and herbaceous growth, mainly buttonbush, are common. The peninsula areas support woody vegetation consisting of black willow, American sycamore, Eastern cottonwood, American elm, Nuttall oak and buttonbush, assorted vines and other understory. Riverward of Borrow Pit 6, separated by a fringe of woody and herbaceous vegetation, is a large, shallow borrow pit. This pit and adjacent borrow pits support substantial populations of emergent and floating aquatic plants, mainly water lotus. Borrow Pit 6 however, does not support aquatic plants to the extent adjoining borrow pits do. Leveeward, little herbaceous vegetation and no woody vegetation is found. Mixed pasture grasses, mainly Bermuda grass and Johnson grass, are common along the levee.

The SDI for this borrow pit was low, with an SDI of 1.5 compared with an average SDI of 2.2 for all borrow pits. The mean basin slope was 0.02 percent. The first 0.8 foot contour slope was 0.19 percent, a rather sharp drop. However, the bottom of the basin is very flat, thus creating an abrupt bank, but flat-bottomed, gently-sloping pit.

Bottom sediments indicated a trend to be more coarse toward the levee, with a loss of coarse materials toward the river. There was no discernable trend in the distribution of organic matter in the borrow pit. On the downstream sampling transect the highest value (8.2 percent volatile residue) was found near the levee between the island and levee shore. Flooding in Borrow Pit 6 averages 89 days, slightly higher than the average 84 days for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>7</u>	River Mile	<u>460</u>	Percent Days Flooded	<u>30</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>18,215</u>	Shore Development Index	<u>1.6</u>
Max. Depth	<u>4.5</u>	Mean Depth	<u>2.6</u>	Mean Basin Slope	<u>0.03</u>
Control Elevation	<u>79.8</u>	Surface Area	<u>5.2</u>	Volume Development Index	<u>1.7</u>
Shoreline Length	<u>2761</u>	Average Days Flooded	<u>111</u>	Nearness to River	<u>0.9</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	217	60	79.0-79.8	0.557	2760.9	0.08
74	187	51	78.0-79.0	0.914	2538.9	0.06
75	156	43	77.0-78.0	2.399	2364.6	0.02
76	51	14	76.0-77.0	1.249	1329.7	0.02
77	44	12	76.0-Below	0.061	274.1	
78	101	28				
79	157	43				
80	49	13				
81	34	9				

Date Sampled: 23 June 1981

Time Sampled: 1130

Water Quality Data, Surface

Parameter	Location							
	Leveeward		Open Water		Riverward		\bar{X}	
	A	B	A	B	A	B		
DO	5.5	7.5	5.5	7.5	5.5	6.4	6.3	
DO Saturation	75	104	74	103	75	88	87	
pH	7.4	7.7	7.3	7.5	7.3	7.4		
ORP	265	240	250	220	275	210	243	
Conductivity	290	320	395	315	330	290	323	
Temperature	33.0	34.0	32.0	33.0	33.0	33.5	33.1	
Turbidity			56.0	47.0			51.5	
Secchi Disc	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Sediment Percent W.P.	5.7	12.0	3.0	3.5	5.7	8.3	6.5	

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 7

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4				100.00		
6	100.0			99.9		
10	99.9			99.8		
16	99.8			99.6		
20	99.7			99.4		
30	99.7			99.3		
40	99.6		100.0	99.0		
50	99.5	100.0	99.9	98.7	100.0	100.0
70	99.4	99.9	99.8	98.4	99.9	99.8
100	99.2	99.7	99.5	97.9	99.8	99.6
140	99.0	99.6	99.4	97.4	99.7	99.6
200	98.7	99.4	99.3	96.5	99.5	99.3
230	98.5	99.1	99.2	95.8	99.4	99.3

Narrative Description of Borrow Pit 7

Borrow Pit 7 is located in Warren County, Mississippi, on the left bank of the Mississippi River on an inside bend at RM 460. The borrow pit is 0.9 miles from the Mississippi River Channel, immediately north of Island 102 and Eagle Lake Pass, adjacent to the levee, and east of Permanent Bench Mark 82-M. The borrow pit is flanked on three sides by borrow pits, all separated by traverses. The traverse on the south side is used as an access road. Borrow Pit 7 has a surface area of 5.2 acres and a shoreline length of 2,761 feet. The borrow pit has a maximum depth of 4.5 feet and a mean depth of 2.6 feet.

Borrow Pit 7 contains three small islands near the east bankline. Mixed stands of blackwillow, Eastern cottonwood, green ash, pecan, American sycamore, sweetgum, box elder, American elm, and nuttall oak surround the borrow pit on two sides. The same vegetation occurs on the three islands. Numerous vines, shrubs, and forbs are common around the entire pit area. Water flows through the borrow pit during high water, which results in debris being deposited on the southern road/traverse. Buckweed and azolla are common floating aquatic plants.

The SDI for this pit was 1.6, somewhat lower than the average SDI of 2.2 for all borrow pits. The mean basin slope was 0.03 percent, however, the first two contours in the basin averaged more than twice the mean basin slope.

Bottom sediments were generally more coarser than the levee, from in the middle of the pit, or riverward. There was essential no variation in sediment composition from upstream to downstream. Percent silt and clay in the sediments was similar for the midpoint and the levee station, however, residue was almost twice as great in the middle of the pit as the levee. The upstream value was 2.4 percent silt and clay, while the downstream value was 4.3 percent. Borrow pit 7 is flooded for an average of 111 days annually, substantially more than the average for all borrow pits flooding for all pits. Borrow pit 7 will also be flooded for the winter in 1981.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>8</u>	River Mile	<u>593</u>	Percent Days Flooded	<u>27</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>61,516</u>	Shore Development Index	<u>2.6</u>
Max. Depth	<u>4.2</u>	Mean Depth	<u>2.2</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>139.8</u>	Surface Area	<u>16.2</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>5802</u>	Average Days Flooded	<u>98</u>	Nearness to River	<u>0.3</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	209	57	139.0-139.8	2.358	5802.4	0.05
74	180	49	138.0-139.0	4.05	5759.7	0.03
75	144	40	137.0-138.0	3.92	4921.6	0.02
76	30	8	136.0-137.0	4.55	3268.5	0.01
77	13	5	136.0-Below	1.186	1468.8	
78	94	23				
79	139	38				
80	45	12				
81	12	4				

Date Sampled: 29 June 1981

Time Sampled: 1600

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		\bar{X}
	A	B	A	B	A	B	
	DO			9.7	12.3		
DO Saturation			131	160			146
pH	8.5	8.3	8.6	8.1	9.0	8.1	
ORP	280	280	210	275	210	280	251
Conductivity	290	280	290	285	280	290	286
Temperature	32.5	30.0	32.0	29.5	34.0	29.5	31.3
Turbidity			24.5	21.0			22.8
Secchi Disc	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Sediment Percent V.P.	4.5	2.8	6.5	7.3	4.4	7.2	5.4

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 8

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6			100.0			
10			99.8	100.0		
16		100.0	99.5	99.9		
20	100.0	99.9	99.3	99.8		
30	99.9	99.7	99.0	99.8		
40	99.8	99.5	98.7	99.7		
50	99.8	99.2	98.4	99.6		100.0
70	99.8	99.1	97.7	99.4	100.0	99.8
100	99.5	98.8	94.6	97.4	99.9	99.5
140	97.6	98.3	74.2	89.5	99.2	98.9
200	91.8	97.4	49.3	72.2	98.0	97.5
230	88.7	97.0	42.8	67.2	97.3	97.0

Narrative Description of Borrow Pit 8

Borrow Pit 8 is located in Bolivar County, Mississippi, on the left bank of the Mississippi River at RM 593. The borrow pit parallels the levee and is approximately 0.3 miles from the main river channel. The pit is located immediately north of a spur levee and between Levee Stations 1150 and 1200. The borrow pit is one of a cluster of borrow pits and former borrow pits now filled-in and overgrown with vegetation. Borrow Pit 8 is essentially divided into four interconnected sections, with smaller pit areas on the north and east sides, and a main pit area. The main borrow pit is separated into two pools by a traverse that was breached to provide a 75-foot wide connection between adjacent pits. Borrow Pit 8 has a surface area of 16.2 acres and a shoreline length of 5,802 feet. The borrow pit maximum depth is 4.2 feet, with a mean depth of 2.2 feet.

The levee shoreline is characterized by a fringe of woody vegetation and closely cropped Bermuda grass, bitter sneezeweed, thistle, dog fennel, broom sedge, and other pasture weeds. Riverward, woody vegetation consists of American sycamore, green ash, Eastern cottonwood, dogwood, box elder, slippery elm, sugarberry, persimmon and rose mallow. Vines and dense understory occur around the pit where there is no grazing.

The SDI for Borrow Pit 8 is 2.0, near the average SDI of 2.2 for all borrow pits. The mean basin slope is 0.02 percent which is indicative of the relatively flat, saucer-shaped pit bottom.

Bottom sediments in Borrow Pit 8 are generally more coarse than sediments in other borrow pits. The riverward, upstream sediments contain more than 47 percent sands. Percent volatile residue in sediments was generally low on the levee side, and higher in the middle of the borrow pit and riverward. Borrow Pit 8 floods an average of 98 days per year, somewhat higher than the average 84 days for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>9</u>	River Mile	<u>595</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>9,780</u>	Shore Development Index	<u>1.4</u>
Max. Depth	<u>3.5</u>	Mean Depth	<u>1.7</u>	Mean Basin Slope	<u>0.03</u>
Control Elevation	<u>137.2</u>	Surface Area	<u>3.3</u>	Volume Development Index	<u>1.5</u>
Shoreline Length	<u>1916</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>1.1</u>
Relative Location	<u>Concave</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	137.0-137.2	0.187	1916.3	0.05
74	170	47	136.0-137.0	0.678	1888.4	0.06
75	128	35	135.0-136.0	1.030	1631.0	0.03
76	18	5	134.0-135.0	1.351	1372.5	0.01
77	5	1	134.0-Below	0.053	186.7	
78	58	19				
79	114	31				
80	41	11				
81	10	3				

Date Sampled: 29 June 1981 Time Sampled: 1605

Water Quality Data, Surface

Parameter	Location					
	Leveeward		Open Water		Riverward	
	A	B	A	B	A	B
DO			10.6	9.8		10.1
DO Saturation			139	132		136
pH	8.3	8.1	8.1	8.3	8.2	8.2
ORP	280	270	280	280	280	282
Conductivity	425	435	435	435	430	433
Temperature	32.5	31.0	30.0	32.0	30.1	31.4
Turbidity			11.0	16.0		10.1
Secchi Disc	1.1	0.3	0.3	0.2	0.3	0.3
Sediment Percent V.F.	1.1	1.6	8.6	10.1	8.6	7.8

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 9

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6	100.0				100.0	100.0
10	99.9		100.0		99.9	99.9
16	99.9		99.9		99.3	99.6
20	99.8	100.0	99.8	100.0	98.8	99.1
30	99.6	99.9	99.7	99.9	98.1	98.3
40	99.6	99.8	99.6	99.8	97.5	97.5
50	99.4	99.8	99.6	99.8	96.8	96.8
70	99.3	99.8	99.4	99.7	96.1	95.8
100	99.1	99.7	99.2	99.7	95.0	95.0
140	99.0	99.5	99.0	99.7	94.3	94.3
200	98.9	99.4	98.9	99.6	93.4	92.6
230	98.8	99.3	98.8	99.5	92.9	93.3

Narrative Description of Borrow Pit 9

Borrow Pit 9 is located at RM 595 in Bolivar County, Mississippi, on the left bank of the Mississippi River. It is immediately adjacent to the levee and north of Levee Station 1020. The borrow pit is approximately 1 mile from the river and south of an old oxbow, Lake Concordia. At high river stages Borrow Pit 9 and Lake Concordia are confluent. Borrow Pit 9 is one of a series of borrow pits lying on an outside bend with the long axis of the pit perpendicular to the channel. Borrow Pit 9 has a surface area of 3.3 acres and a shoreline length of 1,916 feet. The borrow pit maximum depth is 3.5 feet with a mean depth of 1.7 feet.

The borrow pit is bordered on all but the levee side by woody vegetation consisting of black willow, osage orange, honey locust, Nuttall oak, overcup oak, Eastern cottonwood, swamp privet and roughleaf dogwood. Vines and herbaceous plants, particularly annual elder, cocklebur and dock species are common. Leveeward, vegetation is closely cropped pasture grasses, primarily Bermuda grass.

The SDI for Borrow Pit 9 was 1.4 as compared with an average SDI for all borrow pits of 2.2. The mean basin slope was 0.03 percent, however the upper two contours had slopes of 0.05 percent and 0.06 percent, respectively. The bottom contour was only 0.01 percent.

Bottom sediments consisted of greater than 92 percent silts at all stations. Volatile residue was characteristically high at all stations, ranging from 7 percent volatile residue on the leveeward eastern-most station to 10.1 percent in the center of the pit on the western-most station. Borrow Pit 9 floods an average of 84 days per year, which equals the average days flooded for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>10</u>	River Mile	<u>456</u>	Percent Days Flooded	<u>29</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>45,495</u>	Shore Development Index	<u>1.0</u>
Max. Depth	<u>4.8</u>	Mean Depth	<u>2.8</u>	Mean Basin Slope	<u>0.03</u>
Control Elevation	<u>81.6</u>	Surface Area	<u>9.1</u>	Volume Development Index	<u>1.7</u>
Shoreline Length	<u>3441</u>	Average Days Flooded	<u>104</u>	Nearness to River	<u>0.1</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	213	58	81.0-81.6	0.492	3440.5	0.01
74	182	50	80.0-81.0	0.944	3374.0	0.08
75	148	41	79.0-80.0	1.221	3152.3	0.06
76	43	12	78.0-79.0	1.956	2995.2	0.03
77	29	8	77.0-78.0	4.067	2720.4	0.01
78	96	26	77.0-Below	0.372	754.8	
79	149					
80	4					
81	33					

Date Sampled: 6 July 1981 Time Sampled: 1330

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		X
	A	B	A	B	A	B	
DO	7.3	5.7	6.8	6.4	6.7	6.7	6.6
DO Saturation	70	70	83	79	83	82	81
pH	7.7	7.5	7.6	7.5	7.7	7.5	
ORP	300	190	280	210	300	290	262
Conductivity	320	320	325	320	325	320	322
Temperature	26.5	27.0	26.5	26.5	27.0	26.5	26.7
Turbidity			12.0	16.0			14.0
Secchi Disc	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sediment Percent V.P.	6.6	6.7	6.2	3.2	1.0	1.7	4.0

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 10

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						100.0
6						99.9
10						99.8
16		100.0	100.0			99.7
20		99.9	99.9			99.6
30	100.0	99.9	99.9	100.0	100.0	99.6
40	99.9	99.9	99.8	99.9	99.9	99.4
50	99.9	99.8	99.8	99.8	99.9	99.1
70	99.8	99.6	99.5	99.8	99.8	98.2
100	99.2	97.8	91.8	99.7	96.9	90.6
140	96.1	93.8	63.5	99.4	87.0	62.8
200	90.7	88.2	29.7	98.8	75.5	65.5
230	88.3	86.7	24.6	98.3	73.0	32.3

Narrative Description of Borrow Pit 10

Borrow Pit 10 is located in Madison Parish, Louisiana, on the right bank of the Mississippi River at RM 456. The borrow pit lies adjacent to the levee and east of Bench Mark (BM) L-23-11. The borrow pit is approximately 0.1 mile from the Mississippi River on Miliken's Bend. The borrow pit has a surface area of 9.1 acres and a shoreline length of 3,441 feet. Maximum depth of the borrow pit is 4.8 feet with a mean depth of 2.8 feet.

Closely cropped pasture weeds and Bermuda grass characterize vegetation on the levee shoreline, while on the other three sides of the borrow pit, Eastern cottonwood and black willows dominate. Vines, especially peppervine, are abundant riverward.

The SDI for Borrow Pit 10 was 1.6, somewhat lower than the average SDI of 2.2 for all borrow pits. Mean basin slope was 0.03 percent, however the first three contours were 0.01, 0.08, and 0.06 percent slope indicating a drop-off somewhat greater than most borrow pits.

Bottom sediments were more sandy than most other borrow pits. Riverward sampling stations were 24.6 percent silt upstream and 32.3 percent silt downstream. Leveeward, sediments were more typical of other borrow pits with an 88.3 percent silt upstream and 98.3 percent silt downstream. The lowest sediment percent volatile residue concentrations were found riverward, with 1.0 percent and 1.7 percent volatile residue upstream and downstream, respectively. Borrow Pit 10 floods an average 104 days per year, greater than the average 84 days flooded for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>11</u>	River Mile	<u>602</u>	Percent Days Flooded	<u>27</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>4,056</u>	Shore Development Index	<u>2.8</u>
Max. Depth	<u>1.6</u>	Mean Depth	<u>0.6</u>	Mean Basin Slope	<u>0.03</u>
Control Elevation	<u>143.7</u>	Surface Area	<u>4.3</u>	Volume Development Index	<u>1.1</u>
Shoreline Length	<u>4372</u>	Average Days Flooded	<u>98</u>	Nearness to River	<u>2.1</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	143.0-143.7	1,973	4371.8	0.03
74	170	47	143.0-Below	2,363	2894.0	
75	128	35				
76	18	5				
77	5	1				
78	68	19				
79	114	31				
80	41	11				
81	10	3				

Date Sampled: 6 July 1981

Time Sampled: 1700

Water Quality Data, Surface

Parameter	Location							
	Leveeward		Open Water		Riverward		X̄	
	A	B	A	B	A	B		
DO	7.5	7.3	5.9	7.4	7.2	5.8	6.9	
DO Saturation	100	94	78	94	95	75	89	
pH	8.9	8.4	8.9	8.4	8.8	8.7		
ORP	230	265	220	230	220	240	234	
Conductivity	330	335	340	390	400	445	373	
Temperature	31.0	29.0	30.5	28.5	30.5	29.5	29.8	
Turbidity			21.0	18.0			19.5	
Secchi Disc	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Sediment Percent V.R.	5.8	4.7	6.2	5.9	6.3	6.1	5.8	

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 11

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6						
10						
16	100.0			100.0		
20	99.8			99.9		
30	99.7			99.9		
40	99.6			99.9		
50	99.5		100.0	99.9		100.0
60		100.0	99.9	99.8	100.0	99.9
100	99.3	99.9	99.8	99.7	99.9	99.8
140	99.2	99.9	99.7	99.7	99.9	99.8
200	99.0	99.8	99.6	99.6	99.9	99.7
230	98.7	99.8	99.5	99.5	99.9	99.6

Narrative Description of Borrow Pit 11

Borrow Pit 11 is located in Bolivar County, Mississippi, on the left bank of the Mississippi River near RM 602. The borrow pit is adjacent to the levee and west of Levee Station 720. The borrow pit is approximately 2.1 miles from the Mississippi River and is one of a complex of borrow pits that are hydrologically connected. The borrow pit has a convoluted shoreline and encompasses several islands and a peninsula above the control elevation. Borrow Pit 11 has a surface area of 4.3 acres and a total shoreline length of 4,372 feet. Maximum depth of the borrow pit is 1.6 feet, and mean depth is 0.6 feet.

The borrow is almost entirely surrounded by woody vegetation consisting of American sycamore, Eastern cottonwood, sugarberry, green ash, box elder, osage orange, black willow, bald cypress, Nuttall and overcup oak. Vines and herbaceous plants are numerous. The islands and peninsula are dominated by buttonbush and black willow.

The SDI is 2.8, substantially higher than the average SDI of 2.2 for all borrow pits, and reflects the broken and convoluted shoreline. The mean basin slope for the two contours below the control elevation was 0.03 percent indicating a generally flat, saucer-shaped bottom.

Bottom sediments leveeward contained more coarse sandy material than those riverward, however, the percent silt-clay fraction for all stations was essentially the same. Percent volatile residue was similar at all stations, ranging from 4.7 percent volatile residue at the downstream, leveeward station to 6.3 percent at the upstream, riverward station. Borrow Pit 11 floods an average of 98 days per year, fourteen days greater than the average 84 days flooded for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>12</u>	River Mile	<u>377</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>29,973</u>	Shore Development Index	<u>1.7</u>
Max. Depth	<u>4.0</u>	Mean Depth	<u>2.1</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>55.0</u>	Surface Area	<u>9.3</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>3786</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>0.7</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	54.0-55.0	1.605	3786.7	0.01
74	170	47	53.0-54.0	2.538	3563.7	0.03
75	128	35	52.0-53.0	3.014	2278.2	0.02
76	16	5	52.0-Below	3.144	1936.0	
77	5	1				
78	68	19				
79	114	31				
80	41	11				
81	1	1				

Date Sampled: 17 July 1981 Time Sampled: 1230

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		X
	A	B	A	B	A	B	
DO	4.8	5.5	3.3	7.2	4.1	5.9	5.7
DO Saturation	64	104	44	99	55	93	77
pH	7.6	8.1	7.5	8.0	7.6	7.9	
ORP	280	270	260	270	250	270	267
Conductivity	310	310	310	310	310	310	310
Temperature	31.0	33.0	30.5	32.5	31.0	32.0	31.7
Turbidity			17.0	19.0			18.0
Secchi Disc	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Sediment Percent T.S.	5.0	0.8	5.4	5.5	5.6	5.1	5.1

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 12

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4	100.0			100.0		
6	98.6			95.5		
10	97.9			94.6		
16	97.2			93.8	100.0	100.0
20	96.6			93.5	99.9	99.9
30	96.1	100.0		93.1	99.9	99.8
40	93.7	99.9		92.7	99.8	99.8
50	87.0	99.8	100.0	92.1	99.8	99.8
70	83.8	99.8	99.9	91.4	99.7	99.7
100	81.1	99.7	99.8	89.9	98.5	99.4
140	76.0	99.4	99.6	86.0	95.4	98.0
200	62.4	98.8	99.4	80.0	90.9	94.0
230	57.9	98.4	99.2	77.3	89.1	92.9

Narrative Description of Borrow Pit 12

Borrow Pit 12 is located on the Tensas Parish/Concordia Parish boundary on the right bank of the Mississippi River at RM 377. The borrow pit is east of Levee Station 6900 and lies adjacent to the levee. The borrow pit is located 0.7 miles from the Mississippi River and is one of a series of ten borrow pits, all hydrologically connected by breaks excavated in the traverses that had previously separated individual pits. The borrow pit has a surface area of 9.3 acres and a shoreline length of 3,786 feet. Maximum depth of Borrow Pit 12 is 4.0 feet, and mean depth of 2.1 feet.

The borrow pit is almost devoid of woody vegetation surrounding the borrow pit with the exception of two clusters of black willow, American sycamore and Eastern cottonwood on the eastern shoreline. The remaining vegetation consists of closely cropped Bermuda grass and pasture weeds.

The SDI for Borrow Pit 12 is 1.7, less than the average SDI of 2.2 for all borrow pits. The mean basin slope is 0.02 percent and reflects the broad, gently sloping contour of the borrow pit basin.

Bottom sediments on the levee side were substantially more sandy than those sediments sampled in the middle or riverward stations. The lowest percent volatile residue was 2.8 percent at the downstream, leveeward station, while the highest recorded volatile material sampled was 6.6 percent recorded at the upstream, riverward station. Borrow Pit 12 floods an average of 84 days per year, the same number of days as the average for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>13</u>	River Mile	<u>656</u>	Percent Days Flooded	<u>16</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>309,178</u>	Shore Development Index	<u>2.6</u>
Max. Depth	<u>16.9</u>	Mean Depth	<u>3.9</u>	Mean Basin Slope	<u>0.05</u>
Control Elevation	<u>171.0</u>	Surface Area	<u>53.4</u>	Volume Development Index	<u>0.7</u>
Shoreline Length	<u>14,008</u>	Average Days Flooded	<u>56</u>	Nearness to River	<u>0.3</u>
Relative Location	<u>Convex</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	156	43	170.0-171.0	11.889	14,008.3	0.03
74	110	30	169.0-170.0	10.759	20,790.5	0.04
75	80	22	168.0-169.0	6.970	11,881.2	0.04
76	0	0	167.0-168.0	7.299	12,029.4	0.04
77	0	0	166.0-167.0	4.555	11,903.1	0.06
78	47	13	165.0-166.0	2.433	10,594.3	0.10
79	79	22	164.0-165.0	2.403	10,251.0	0.08
80	35	10	163.0-164.0	1.644	7,385.2	0.07
81	0	0	162.0-163.0	1.007	3,050.9	0.06
			161.0-162.0	0.908	2,330.5	0.06
			160.0-161.0	0.539	2,159.1	0.09
			159.0-160.0	0.452	2,019.9	0.10
			158.0-159.0	0.390	1,880.5	0.11
			157.0-158.0	0.636	1,764.3	0.06
			156.0-157.0	0.473	1,434.6	0.06
			155.0-156.0	0.376	1,118.7	0.06
			154.0-Below	0.647	860.7	

Date Sampled: 10 July 1981

Time Sampled: 1500

Water Quality Data, Surface

Parameter	Location						
	Leveeward		Open Water		Riverward		X
	A	B	A	B	A	B	
DO	8.8	9.2	9.5	8.9	8.1	8.9	8.9
DO Saturation	123	130	131	125	112	124	124
pH	8.3	8.4	8.5	8.4	8.4	8.5	
ORP	290	305	300	310	305	310	303
Conductivity	330	320	320	315	310	310	318
Temperature	34.5	35.5	33.5	35.0	33.5	34.5	34.4
Turbidity			8.0	9.0			8.5
Secchi Disc	0.3	0.4	0.4	0.4	0.3	0.3	0.4
Sediment Percent V.R.	5.4	5.2	1.2	4.3	4.6	3.5	4.0

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 13

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4			100.0			
6	100.0		99.8		100.0	
10	99.9	100.0	99.5		99.9	100.0
16	99.7	99.8	99.1	100.0	99.9	99.8
20	99.5	99.7	98.8	99.9	99.8	99.6
30	99.2	99.5	98.4	99.9	99.6	99.5
40	98.9	99.3	97.9	99.7	99.4	99.4
50	98.5	87.8	95.9	99.2	98.8	98.8
70	97.1	36.0	87.1	96.1	96.1	93.4
100	94.5	26.3	69.0	90.7	83.6	61.5
140	90.4	22.5	52.3	84.6	76.5	50.9
200	84.9	19.0	43.4	79.6	68.6	42.8
230	82.3	17.7	41.6	77.9	66.3	41.8

Narrative Description of Borrow Pit 13

Borrow Pit 13 is located in Phillips County, Arkansas, on the right bank of the Mississippi River at RM 656. The borrow pit is on the inside of Montezuma Bend, east of Levee Marker 9/10 and BM 9/10 and is 0.3 miles from the river channel. Culverts constructed in the borrow pit maintain a minimum pool elevation in the deeper portion of the pit. Surface area of the borrow pit is 53.4 acres, and is the largest borrow pit sampled in this study. The shoreline length is 14,008 feet or 2.7 miles in length. Maximum depth of the pit is 16.9 feet, while the mean depth is 3.9 feet.

The borrow pit is surrounded by agricultural land with occasional stands of osage orange trees in scattered groups. Other woody vegetation recorded was American sycamore, Eastern cottonwood, honey locust, American elm, and black willow. On the leveeside, pasture grasses mainly Bermuda grass, are closely cropped due to heavy grazing pressure. Understory is absent due in part to grazing.

The SDI for this borrow pit was 2.6, higher than the average of 2.2 for all borrow pits. The mean basin slope was 0.05 percent, and reflects a greater bank slope for this borrow pit than most others investigated. Approximately 30 percent of the bottom area was measured at a 0.06 percent slope or greater.

Bottom sediments were generally coarse throughout the borrow pit, with the leveeward side indicating finer sediments than the remaining bottom areas. Volatile residue ranged from 1.2 percent in the upstream midpoint sampling station, which was the location of the coarsest sediments, to 5.4 percent at the upstream leveeward station which was the location of the finest sediments. Borrow Pit 13 floods an average of 56 days per year compared with the average for all borrow pits of 84 days per year.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>14</u>	River Mile	<u>584</u>	Percent Days Flooded	<u>24</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>224,106</u>	Shore Development Index	<u>3.0</u>
Max. Depth	<u>5.5</u>	Mean Depth	<u>2.9</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>137.0</u>	Surface Area	<u>47.7</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>15,064</u>	Average Days Flooded	<u>89</u>	Nearness to River	<u>4.3</u>
Relative Location	<u>Concave</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	204	56	136.0-137.0	3.005	15,064.1	0.12
74	175	48	135.0-136.0	7.832	15,507.0	0.04
75	135	37	134.0-135.0	10.842	12,974.5	0.03
76	19	5	133.0-134.0	18.399	12,126.8	0.01
77	8	2	132.0-133.0	7.419	6,322.8	0.01
78	76	21	132.0-Below	0.152	353.0	
79	118	32				
80	43	12				
81	19	5				

Date Sampled: 15 July 1981

Time Sampled: 1000

Water Quality Data, Surface

Parameter	Leveeward		Location		Riverward		X
	A	B	A	B	A	B	
DO	8.0	8.0	7.9	5.5	7.9	8.3	7.6
DO Saturation	107	107	106	74	106	111	102
pH	9.1	8.9	8.0	8.8	8.9	8.8	
ORP	200	190	210	200	210	200	202
Conductivity	220	230	230	220	230	220	225
Temperature	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Turbidity			57	57			57
Secchi Disc	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sediment Percent V.R.	1.2	2.2	8.6	5.8	9.6	8.4	6.0

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 14

Sieve Size	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						100.0
6				100.0		99.2
10				99.8	100.0	98.8
16	100.0			99.8	99.9	98.2
20	99.9			99.7	99.8	97.8
30	99.8			99.5	99.7	97.3
40	99.8			99.3	99.7	96.7
50	99.8			99.0	99.5	96.1
70	99.7			98.7	99.4	95.6
100	98.2	100.0	100.0	98.2	99.2	95.3
140	76.3	99.8	99.6	94.5	98.6	94.6
200	37.6	99.0	99.0	75.7	96.0	92.6
230	29.5	99.0	99.0	69.5	94.7	91.4

Narrative Description of Borrow Pit 14

Borrow Pit 14 is located in Desha County, Arkansas, at RM 584 on the right bank of the Mississippi River. The mouth of the Arkansas River lies 6.5 miles east southeast of the borrow pit. The nearest approach of the Mississippi River to Borrow Pit 14 is 4.3 miles to the southeast. The borrow pit is on the concave side of Rosedale Bend, south of BM 3250A and lies between Levee Stations 4350 and 4400. Surface area of the borrow pit is 47.7 acres with a shoreline length of 15,064 feet, or approximately 2.9 miles. Maximum depth of the pit is 5.5 feet while the mean depth is 2.9 feet.

The physical field survey and wildlife use studies of Borrow Pit 14 used the pit as described. However, the fish sampling crew inadvertently sampled an adjacent borrow pit, therefore water chemistry and sediment data described is from a borrow pit immediately west but adjacent to Borrow Pit 14.

Leveeward, the vegetation is managed for hay production. Primary grasses are Bermuda grass and Johnson grass. Riverward, bottomland hardwood forests extend to the river with the exception of the area on the southeast end of the borrow pit where some agricultural activity occurs. Primary woody vegetation consists of black willow, Eastern cottonwood, American Sycamore, sweetgum, Nuttall oak, honey locust, American elm, water oak, and others. Vines and herbaceous understory were dense in the woods.

The SDI for Borrow Pit 14 is 3.0 and reflects the presence of peninsulas, and islands in the Southeast end of the borrow pit. This SDI compares with an average SDI of 2.2 for all borrow pits. The contour interval surface to 1 foot exhibited a slope of 0.12 percent, then leveled off rapidly to a slope of from 0.01 to 0.04 percent for the remainder of the borrow pit bottom. The mean basin slope averaged only 0.02 percent.

Bottom sediments were generally coarse leveeward, with the midpoint and riverward stations ranging from greater than 91 to 99 percent finer than silt-clay. Leveeward stations tested 1.2 to 2.2 percent volatile residue while the more riverward stations ranged from 5.8 to 9.6 percent volatile residue. Borrow Pit 14 floods an average of 89 days per year, as compared with the average for all borrow pits of 84 days per year.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>15</u>	River Mile	<u>659</u>	Percent Days Flooded	<u>16</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>348,228</u>	Shore Development Index	<u>1.6</u>
Max. Depth	<u>7.5</u>	Mean Depth	<u>3.9</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>173.0</u>	Surface Area	<u>53.4</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>8881</u>	Average Days Flooded	<u>56</u>	Nearness to River	<u>1.8</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	156	43	172.0-173.0	4.994	8,880.7	0.05
74	110	30	171.0-172.0	4.235	11,093.2	0.06
75	60	22	170.0-171.0	7.390	10,668.0	0.04
76	0	0	169.0-170.0	7.938	14,176.0	0.03
77	0	0	168.0-169.0	9.015	9,451.3	0.02
78	47	13	167.0-168.0	9.918	4,984.7	0.01
79	79	22	166.0-167.0	6.891	4,364.7	
80	35	10	166.0-Below	2.973	2,329.9	
-1						

Date Sampled: 13 July 1981 Time Sampled: 1145

Water Quality Data, Surface

Parameter	Location						
	Leveeward		Open Water		Riverward		X
	A	B	A	B	A	B	
DO	5.9	6.5	4.9	5.8	5.6	4.6	5.6
DO Saturation	81	89	66	79	77	63	76
pH	7.7	7.7	7.7	7.7	7.8	7.6	
ORP	340	340	240	335	340	330	321
Conductivity	350	360	430	360	350	360	368
Temperature	33.5	33.0	32.0	32.5	33.5	32.5	32.8
Turbidity			11.0	10.0			10.5
Secchi Disc	0.5	0.4	0.4	0.3	0.4	0.3	0.4
Sediment Percent V.F.	11.1	7.7	4.6	18.4		10.0	10.0

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 15

<u>Grain Size Analysis</u>						
<u>Sieve Size</u>	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4	100.0		No Sample	100.0	100.0	100.0
6	99.8	100.0	No Sample	99.9	95.7	99.4
10	99.5	99.9	No Sample	99.7	91.1	99.0
16	98.4	99.6	No Sample	99.4	86.1	98.1
20	97.6	99.5	No Sample	99.2	80.9	97.7
30	96.4	99.4	No Sample	99.1	76.8	96.9
40	95.4	99.2	No Sample	98.7	73.1	96.3
50	94.2	98.9	No Sample	98.3	69.0	95.6
75	92.8	98.4	No Sample	97.0	66.7	94.6
100	91.3	97.0	No Sample	88.6	64.4	92.7
140	89.3	95.1	No Sample	74.7	62.1	86.3
200	85.4	92.0	No Sample	62.9	58.8	76.8
230	83.3	90.6	No Sample	58.7	57.6	74.1

Narrative Description of Borrow Pit 15

Borrow Pit 15 is located in Coahoma County, Mississippi, on the left bank of the Mississippi River at RM 659. The borrow pit is west of Montezuma Bar between Levee Stations 59/15 and 59/46. The pit is approximately 1.8 miles from the river and is one of a series of borrow pits adjacent to the north-south levee. The borrow pit was formerly two different borrow areas separated by a longitudinal north-south mound of high ground which was irregular in elevation. There are numerous interconnections between the separated sections. Surface area of Borrow Pit 15 is 53.4 acres, with a shoreline length of 8,881 feet. Maximum depth of the borrow pit is 7.5 feet, while the mean depth is 3.9 feet.

Black willow is the dominant woody vegetation which is found exclusively on the longitudinal mound separating the two borrow pit basins. Other woody species found on higher elevations on the north and south ends of the borrow pit include Eastern cottonwood, osage orange, green ash, sugarberry, bald cypress, box elder, honey, and water locust among others. Vine and herbaceous growth is abundant. Leveeward, a fringe of black willow separates the borrow pit from the levee which is used for pasture and hay production. Riverward of the borrow pit and beyond the border of woody vegetation, the land is managed for agriculture. Borrow Pit 15 contained an abundance of floating duckweeds, smartweed, nutsedge, and other rooted aquatic plants. Rooted aquatic plants covered approximately 50 percent of the surface area of the borrow pit during 1982-1983.

The SDI was 1.6 for this borrow pit, somewhat lower than the average 2.1 for all borrow pits. Mean basin slope was 0.02 percent, however the first three contours showed a slope of 0.05, 0.06 and 0.04 percent, respectively. The large, comparatively flat, bottom area and linear leveeward bankline tended to dampen the effect of the longitudinal mound and convoluted riverward bankline.

Bottom sediments were generally coarse ranging from approximately 57 percent finer than silt-clay at the midpoint station downstream, to 90 percent finer than silt-clay at the midpoint station on the upstream end. Percent volatile residue ranged from 4.6 percent at the midpoint upstream station to 18.4 percent at the downstream midpoint station. Borrow Pit 15 floods an average of 56 days per year as compared with an average of 84 days for all borrow pits. The pit does not necessarily flood every year. During the period 1973 to 1981, the pit did not flood for three years (1976, 1977, and 1981).

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>16</u>	River Mile	<u>355</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>18,001</u>	Shore Development Index	<u>1.8</u>
Max. Depth	<u>3.0</u>	Mean Depth	<u>1.4</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>49.1</u>	Surface Area	<u>7.4</u>	Volume Development Index	<u>1.4</u>
Shoreline Length	<u>3618</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>0.2</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	49.0-49.1	0.231	3617.5	0.04
74	170	47	48.0-49.0	1.634	3597.6	0.05
75	128	35	47.0-48.0	2.990	3242.8	0.02
76	18	5	47.0-Below	2.589	2647.3	
77	5	1				
78	68	19				
79	114	31				
80	41	11				
81	10	3				

Date Sampled: 10 July 1981 Time Sampled: 1430

Water Quality Data, Surface

Parameter	Location							
	Leveeward		Open Water		Riverward			\bar{X}
	A	B	A	B	A	B		
DO	8.7	8.2	8.0	8.1	8.8	8.9	8.1	
DO Saturation	49	46	53	54	63	52	51	
pH	8.0	8.3	8.0	8.2	8.1	8.3		
RP	255	255	255	255	255	255	255	
Conductivity	359	373	360	373	360	375	364	
Temperature	30.1	31.0	30.2	30.1	30.7	30.5	30.7	
Turbidity			11.5	13.0				12.8
Secchi Disc	1.1	0.2	0.1	0.2	0.1	0.2		0.2
Sediment Percent T.S.	4.2	4.3	4.8	5.0	4.1	4.6		4.4

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 16

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6						
10						
16						100.0
20						99.9
30	100.0	100.0	100.0	100.0	100.0	99.5
40	99.9	99.9	99.9	99.7	99.8	99.3
50	99.8	99.8	99.7	99.5	99.5	99.0
70	99.7	99.6	99.3	99.3	98.8	98.6
100	99.0	98.2	95.7	99.0	95.9	97.6
140	96.3	89.9	79.2	97.0	90.1	93.0
200	90.4	75.8	52.7	91.0	82.7	81.3
230	88.3	71.5	45.5	88.2	80.2	77.1

Narrative Description of Borrow Pit 16

Borrow Pit 16 is located in Concordia Parish, Louisiana, on the right bank of the Mississippi River at RM 355. The borrow pit is parallel to the levee and lies immediately north of the Morville Light. The borrow pit is one of a series of borrow pits which have been reused and reshaped into a series of 10 individual and interconnected borrow pits. Borrow Pit 16 is the southernmost borrow pit of this group. The borrow pit lies east of Levee Station 8700 and is 0.2 miles from the Mississippi River. Surface area of Borrow Pit 16 is 7.4 acres with a shoreline length of 3,617.5 feet. Maximum depth is 3.0 feet while the mean depth is 1.4 feet.

Vegetation surrounding the pit consists of closely cropped pasture grasses, primarily Bermuda grass and pasture weeds. Woody vegetation is composed of isolated black willow occurring on the traverse connecting the borrow pits. Occasional American sycamore and Eastern cottonwood occur at the north end of the series of 10 pits. There is no other understory apparently due to grazing.

The SDI for Borrow Pit 16 was 1.8, less than the average of 2.2 for all borrow pits. Mean basin slope was 0.02 percent with the first and second contours 0.04 percent and 0.05 percent slope, respectively.

Bottom sediments were more coarse riverward at the upstream and downstream stations as compared with the leveeward stations. Bottom sediments ranged from 45.5 percent finer than silt-clay at the upstream riverward station to approximately 88 percent finer than silt-clay at both levee sediment stations. Percent volatile material was comparatively low, ranging from 2 percent volatile residue at the upstream, riverward station to 5.2 percent at the downstream, midpoint station. Borrow Pit 16 floods an average of 84 days per year, and floods every year.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>17</u>	River Mile	<u>773</u>	Percent Days Flooded	<u>7</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>183,100</u>	Shore Development Index	<u>2.3</u>
Max. Depth	<u>5.7</u>	Mean Depth	<u>3.0</u>	Mean Basin Slope	<u>0.03</u>
Control Elevation	<u>235.0</u>	Surface Area	<u>38.1</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>10,498</u>	Average Days Flooded	<u>25</u>	Nearness to River	<u>2.3</u>
Relative Location	<u>Convex</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	68	19	234.0-235.0	2.436	10,498.0	0.11
74	34	9	233.0-234.0	7.080	12,020.0	0.04
75	38	10	232.0-233.0	7.147	10,666.0	0.03
76	0	0	231.0-232.0	13.063	9,045.0	0.01
77	0	0	230.0-231.0	7.226	5,174.0	0.01
78	16	4	230.0-Below	1.108	1,583.2	
79	59	16				
80	12	3				
81	0	0				

Date Sampled: 20 July 1981 Time Sampled: 1830

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		<u>X</u>
	A	B	A	B	A	B	
DO	9.8	9.3	9.3	9.1	9.8	9.4	9.5
DO Saturation	137	129	128	125	133	128	130
pH	8.1	8.2	8.2	8.3	7.9	8.0	
ORP	320	290	290	290	210	315	286
Conductivity	235	240	230	240	230	230	234
Temperature	34.5	34.0	33.5	33.0	32.5	32.5	33.3
Turbidity			15.0	17.0			16.0
Secchi Disc	0.3	0.2	0.4	0.4	0.3	0.3	0.3
Sediment Percent V.R.	10.0	7.8	5.9	5.7	6.6	5.5	6.9

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 17

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4	100.0			100.0		
6	99.8			99.7		
10	99.6			99.4		
16	99.3			99.1		
20	98.9			98.8		
30	98.1	100.0	100.0	98.3		
40	96.4	99.9	99.9	97.7	100.0	100.0
50	94.0	99.7	99.7	96.2	99.8	99.9
70	91.5	99.5	99.6	93.4	99.8	99.8
100	89.9	99.3	99.6	91.4	99.7	99.7
140	88.1	98.8	99.4	89.8	99.5	99.5
200	84.6	97.1	97.9	87.2	98.3	97.4
230	82.6	95.6	97.0	85.7	97.4	95.8

Narrative Description of Borrow Pit 17

Borrow Pit 17 is located in Mississippi County, Arkansas, on the right bank of the Mississippi River at RM 773 and adjacent to Levee Station 98/49. The borrow pit is on the southwest side of a finger-like levee section which lies from west northwest to east southeast. The southeast end of the borrow pit is positioned at the corner of the levee section where the levee makes a right-angle turn to the north northeast. A spur levee connecting with the mainline levee abuts the southeast end of the borrow pit, while the northwest end is connected with an adjacent borrow pit by means of a 24-inch metal pipe. The borrow pit is very long, approximately 5,000 feet, but averages only 325 feet wide. It is located 2.3 miles from the Mississippi River. Surface area of the borrow pit is 38.1 acres with a shoreline length of 10,498 feet. Maximum depth of Borrow Pit 17 is 5.7 feet, while the mean depth is 3.0 feet.

The borrow pit has a fairly straight shoreline, however, it contains three peninsulas and ten islands. The SDI for this pit is 2.3, which is near the average SDI of 2.2 for all borrow pits. Leveeward there is a fringe of pasture grass, scattered stands of trees, and on occasion, row crops are found which separate the borrow pit from the levee. Riverward, a narrow border of woody and herbaceous vegetation separates the borrow pit from mostly agricultural lands. The levee grasses are predominately Bermuda grass and tall fescue, while primary woody species are sweetgum, Eastern cottonwood, American elm, black willow, Eastern red cedar, persimmon, American sycamore, and others. Smartweed and nutsedge are the predominant aquatic plants. The borrow pit has historically been drained for agricultural production. Mean basin slope averaged 0.03 percent however, the surface to 1-foot contour was a 0.11 percent slope which quickly leveled-off to 0.04 percent slope. The slope of the expansive, flat-bottom of the borrow pit averaged only 0.01 percent.

Bottom sediments leveeward were more coarse than those riverward, with silt-clay greater than 82 percent at the two levee stations as compared with silt-clay greater than 95 percent at the midpoint and downstream stations. Levee stations also exhibited greater volatile residue than midpoint or riverward stations, which ranged from 5.5 percent volatile residue at the midpoint, open water station to 10 percent volatile residue at the upstream, leveeward station. Borrow Pit 17 floods an average of 25 days per year, significantly less than the 84 average days flooded for all borrow pits. During wildlife studies conducted from 1981 through 1983, the borrow pit was reported as almost dry during the winter of 1981-1982 and during the fall of 1983.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>10</u>	River Mile	<u>323</u>	Percent Days Flooded	<u>23</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>10,779</u>	Shore Development Index	<u>2.6</u>
Max. Depth	<u>5.1</u>	Mean Depth	<u>2.2</u>	Mean Basin Slope	<u>0.05</u>
Control Elevation	<u>41.8</u>	Surface Area	<u>3.3</u>	Volume Development Index	<u>1.3</u>
Shoreline Length	<u>3559</u>	Average Days Flooded	<u>84</u>	Nearness to River	<u>1.8</u>
Relative Location	<u>Conver</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	200	55	41.0-41.8	0.971	3558.8	0.06
74	170	47	40.0-41.0	0.643	2375.4	0.08
75	128	35	39.0-40.0	0.547	2095.4	0.08
76	18	5	38.0-39.0	0.866	1857.7	0.04
77	5	1	37.0-38.0	0.264	1016.0	0.06
78	68	19	37.0-Below	0.043	319.4	
79	114	31				
80	41	11				
81	10	3				

Date Sampled: 23 July 1981

Time Sampled: 0845

Water Quality Data, Surface

Parameter	Location							
	Leveeward		Open Water		Riverward		\bar{X}	
	A	B	A	B	A	B		
DO	0.2	0.4	0.2	0.1	0.8	1.8	0.6	
DO Saturation	3	5	3	1	11	24	8	
pH	7.0	6.9	7.0	6.9	7.0	7.0		
ORP	10	-70	-100	-125	-35	55		
Conductivity	520	500	500	560	510	500	515	
Temperature	30.2	30.9	30.0	26.0*	30.5	30.7	29.7	
Turbidity			18.0	18.5			18.3	
Secchi Disc	0.2	0.3	0.3	0.3	0.3	0.3	0.3	
Sediment Percent V.R.	5.4	6.8	6.3	5.8	6.1	5.4	6.0	

*This sample was taken 0.7 m under the surface.

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 18

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6						
10						
16						
20			100.0			100.0
30			99.9			99.9
40			99.8			99.8
50		100.0	99.8			99.7
70		99.9	99.6			99.6
100	100.0	99.8	99.6	100.0	100.0	99.4
140	99.9	99.7	99.4	99.8	99.9	99.3
200	99.7	99.5	98.5	99.6	99.6	98.5
230	99.6	99.3	97.7	99.2	99.3	97.9

Narrative Description of Borrow Pit 18

Borrow Pit 18 is located in Concordia Parish, Louisiana, on the right bank of the Mississippi River at RM 323. The borrow pit parallels the levee and is located at Levee Station 10320 on a convex bend of the river. The borrow pit is a part of the Red River Wildlife Management Area and is located approximately 1.8 miles from the Mississippi River. The borrow pit has a surface area of 3.3 acres and a shoreline of 3,559 feet. Maximum depth is 5.1 feet while the mean depth is 2.2 feet.

Primary vegetation leveeward is Bermuda and Johnson grass. A fringe of willow, cottonwood, and sycamore trees separates the borrow pit from the levee. Riverward, conditions are typical of a bottomland hardwood forest with tree species that are mainly black willow, Eastern cottonwood, and American sycamore with other species such as deciduous holly, buttonbush, honey locust, Nuttall oak, swamp privet, and sugarberry very common.

The SDI for Borrow Pit 18 was 2.6 and reflected the highly convoluted shape of the pit. Mean basin slope was 0.05 percent, higher than most other borrow pits which averaged 0.04 percent. The first three contours from the controlling elevation (41.8 NGVD) to elevation (39.0 NGVD) were 0.06, 0.08, and 0.08 percent, respectively. The borrow pit supported abundant aquatic vegetation, including smartweed and duckweed, and many emergent tree sprouts despite the abrupt slopes of the first 3 feet of depth.

Bottom sediments were fine-grained, with greater than 97 percent silt-clay at all sampling stations. Percent organic residue was fairly consistent throughout the borrow pit, ranging from a low of 5.4 percent volatile residue to a high value of 6.8 percent volatile residue. Borrow Pit 18 floods every year at an average of 84 days per year, the same as the average period flooded for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>19</u>	River Mile	<u>877</u>	Percent Days Flooded	<u>17</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>6,479</u>	Shore Development Index	<u>2.0</u>
Max. Depth	<u>1.1</u>	Mean Depth	<u>0.5</u>	Mean Basin Slope	<u>0.01</u>
Control Elevation	<u>279.1</u>	Surface Area	<u>7.4</u>	Volume Development Index	<u>1.5</u>
Shoreline Length	<u>4090</u>	Average Days Flooded	<u>63</u>	Nearness to River	<u>0.8</u>
Relative Location	<u>Concave</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	147	40	279.0-279.1	0.893	4089.7	0.01
74	118	32	278.0-279.0	6.355	4173.7	0.01
75	92	25	278.0-Below	0.144	328.7	
76	10	3				
77	8	2				
78	54	15				
79	91	25				
80	36	10				
81	7	2				

Date Sampled: 26 July 1981 Time Sampled: 1830

Water Quality Data, Surface

Parameter	Leveeward		Location		Riverward		X
	A	B	Open Water		A	B	
			A	B			
DO	*	*	7.3	8.1	7.3	8.1	7.7
DO Saturation			102	113	104	113	108
pH			9.4	9.5	9.4	9.5	
ORP			250	220	220	210	225
Conductivity			300	280	300	270	288
Temperature			34.5	34.5	35.5	34.5	34.8
Turbidity			43.0	38.0			40.5
Secchi Disc			0.1	0.1	0.1	0.1	0.1
Sediment Percent V.R.	5.0	6.2	6.4	5.4	4.7	5.2	5.5

*Water too shallow for sampling.

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 19

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6			100.0			
10			99.9	100.0		100.0
16			99.8	99.9		99.9
20			99.7	99.8		99.9
30	100.0	100.0	99.5	99.8		99.8
40	99.9	99.9	99.3	99.4	100.0	99.7
50	99.8	99.7	98.9	98.8	99.9	99.6
70	99.8	99.3	97.4	97.5	99.8	99.1
100	99.7	98.6	93.2	95.7	99.8	98.1
140	98.9	96.7	81.6	93.2	99.6	96.1
200	97.6	94.2	70.0	90.1	99.4	94.1
230	97.0	93.5	67.3	89.2	99.3	93.5

Narrative Description of Borrow Pit 19

Borrow Pit 19 is located in New Madrid County, Missouri, on the right bank of the Mississippi River at RM 877. The borrow pit is on the concave side of the river bend, opposite Marr Towhead. The pit is adjacent and parallel to the levee, immediately east of Levee Station 2/3 and BM 2/3S. Borrow Pit 19 is located 0.8 miles from the Mississippi River. The surface area is 7.4 acres with a shoreline length approximately 4,090 feet. Maximum depth of the borrow pit is 1.1 feet, with the mean depth 0.5 feet.

The borrow pit is surrounded by a fringe of woody vegetation, principally black willow. Other species present at the northern and southern ends are American sycamore, Eastern cottonwood, honey locust, water locust, sweetgum, sassafras, and others. Leveeward, the levee grasses are typically tall fescue and native red clover which is occasionally used for grazing. Riverward, and beyond the fringe of black willow, the land is managed for agricultural production. The pit is connected by a ditch at the northern end to an adjacent pit, while at the southern end, a 24-inch culvert drains the pit area. The borrow pit was observed to dry-out each year from 1981 to 1983. During these periods, nutsedge completely covered the borrow pit bottom. Vines and understory are dense on the northern and southern ends of the borrow pit, but are essentially absent on the eastern and western shoreline fringe areas.

The SDI is 2.0, as compared with the average SDI for all borrow pits of 2.2. Contour intervals indicate a mean basin slope of 0.01. The basin in this borrow pit is very flat with little relief from the controlling elevation to the bottom.

Bottom sediments are generally 90 percent or greater silt-clay. However, the upstream, riverward sediments are somewhat more coarse, only 67 percent or greater is silt-clay. Borrow Pit 19 floods every year an average of 63 days per year, somewhat less than the average 84 days per year for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>20</u>	River Mile	<u>305</u>	Percent Days Flooded	<u>27</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>51,313</u>	Shore Development Index	<u>1.3</u>
Max. Depth	<u>7.7</u>	Mean Depth	<u>4.6</u>	Mean Basin Slope	<u>0.05</u>
Control Elevation	<u>40.0</u>	Surface Area	<u>6.8</u>	Volume Development Index	<u>1.8</u>
Shoreline Length	<u>2580</u>	Average Days Flooded	<u>99</u>	Nearness to River	<u>0.3</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
72	100	55	39.0-40.0	0.374	2579.9	0.16
74	176	48	38.0-39.0	0.619	2524.4	0.09
76	161	39	37.0-38.0	0.652	2473.0	0.09
78	17	5	36.0-37.0	0.727	2414.5	0.08
79	35	1	35.0-36.0	0.774	2347.1	0.07
79	44	1	34.0-35.0	1.106	2257.8	0.05
79	154	42	33.0-34.0	1.930	2142.9	0.02
80	50	14	33.0-Below	0.661	1483.5	
81	34	3				

Date Sampled: 21 July 1981 Time Sampled: 0845

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		\bar{X}	
	A	B	A	B	A	B		
Water Depth	3.4	3.5	3.7	3.1	3.3	3.1	3.4	
Water Saturation	52	47	50	42	44	42	46	
pH	7.1	7.1	7.1	7.3	7.2	7.3		
SI	395	240	343	322	350	320	343	
Conductivity	251	250	251	250	251	250	250	
Temperature	31.5	31.8	31.5	31.5	31.5	31.5	31.6	
Salinity			50.0	40.0			45.0	
Chloride	0.2	0.2	0.2	0.1	0.2	0.1	0.2	
Sulfate Percent T.D.	0.0	3.1	6.0	5.1	3.9	6.3	4.7	

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 20

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6			100.0			
10	100.0		99.9			
16	99.9		99.8			
20	99.8		99.7	100.0		
30	99.7		99.6	99.9		
40	99.6	100.0	99.4	99.8	100.0	100.0
50	99.4	99.9	99.3	99.7	99.9	99.9
70	99.3	99.7	99.1	99.6	99.8	99.8
100	99.1	99.7	98.8	99.5	99.8	99.6
140	98.2	99.6	98.3	98.9	99.7	99.6
200	93.4	99.3	96.4	95.3	99.3	99.4
230	90.3	99.0	94.5	93.0	99.1	99.2

Narrative Description of Borrow Pit 20

Borrow Pit 20 is located in Concordia Parish, Louisiana on the right bank of the Mississippi River at RM 305. The borrow pit is in the Three Rivers Wildlife Management Area and lies between Levee Stations 731 to 741. It is one of a series of borrow pits and cleared areas of low elevation all connected hydrologically at higher river stages. Borrow Pit 20 is located 0.3 miles from the Mississippi River. It has a surface area of 6.8 acres with a shoreline length of 2,580 feet. Borrow Pit 20 has a maximum depth of 7.7 feet and a mean depth of 4.6 feet.

A fringe of woody vegetation surrounds the pit and consists mainly of black willow. Other woody vegetation includes American Sycamore, honey locust, Eastern cottonwood, green ash, box elder, and persimmon. Vines and understory among the trees is very dense, and includes a large variety of herbaceous plants. A bottomland hardwood forest typical of the batture lands occurs between the borrow pit and river. The adjoining levee slopes are mainly Bermuda and Johnson grasses.

SDI for Borrow Pit 20 was 1.3, somewhat lower than the average 2.2 for all borrow pits. Mean basin slope was 0.05 percent, and reflected the fairly steep bank on three of the four borrow pit sides.

Bottom sediments were 90 percent or greater silt-clay. However, more coarse sediments were generally found along the levee and upstream. Volatile residue was generally low, ranging from 3.1 percent at the downstream levee side of the pit to 6.3 percent at the downstream, river side. Borrow Pit 20 floods an average of 99 days annually compared with an average of 84 days per year for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>21</u>	River Mile	<u>881</u>	Percent Days Flooded	<u>7</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>23,167</u>	Shore Development Index	<u>2.0</u>
Max. Depth	<u>3.5</u>	Mean Depth	<u>1.7</u>	Mean Basin Slope	<u>0.02</u>
Control Elevation	<u>287.0</u>	Surface Area	<u>9.2</u>	Volume Development Index	<u>1.5</u>
Shoreline Length	<u>4545</u>	Average Days Flooded	<u>24</u>	Nearness to River	<u>2.5</u>
Relative Location	<u>Convex</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	69	19	286.0-287.0	2.394	4544.6	0.04
74	28	8	285.0-286.0	3.841	3660.3	0.02
75	36	10	284.0-285.0	2.773	2656.8	0.01
76	0	0	284.0-Below	0.056	591.3	
77	0	0				
78	19	5				
79	57	16				
80	11	3				
81	0	0				

Date Sampled: 28 July 1981

Time Sampled: 1740

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		\bar{X}
	A	B	A	B	A	B	
DO	8.3	7.4	8.2	7.5	8.3	7.6	7.9
DO Saturation	112	99	111	100	111	102	106
pH	8.2	7.6	7.7	7.4	7.7	7.9	
ORP	335	410	400	410	400	380	389
Conductivity	-*	-	-	-	-	-	
Temperature	32.0	31.0	32.0	31.0	31.5	31.5	31.5
Turbidity			71.0	78.0			74.5
Secchi Disc	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sediment Percent V.R.	8.6	3.7	6.4	3.2	5.2	3.4	5.1

*Field recording error.

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 21

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4				100.0		
6	100.0			99.8		100.0
10	99.4			99.6	100.0	99.9
16	97.9			99.2	99.9	99.7
20	96.8		100.0	98.6	99.8	99.6
30	95.2	100.0	99.9	98.0	99.6	99.4
40	93.4	99.9	99.7	97.3	99.3	99.3
50	91.2	99.8	99.7	96.3	98.6	98.8
70	87.2	99.8	99.6	92.9	95.9	97.2
100	78.8	99.7	99.6	84.4	88.6	92.0
140	62.7	99.1	99.5	64.9	75.2	80.6
200	48.9	97.7	99.2	48.6	59.5	65.7
230	45.9	97.1	99.0	45.5	55.3	61.6

Narrative Description of Borrow Pit 21

Borrow Pit 21 is located in New Madrid County, Missouri, on the right bank of the Mississippi River at RM 881. The borrow pit is adjacent to the levee and is one of a series of borrow pits interconnected by culverts and drains. The borrow pit is located about 2.5 miles from the main river channel and is between Levee Stations 0/0N and 1N/2N. Controlling elevation for this borrow pit is an elevation of 287.0. At that elevation a 0.1-foot difference separates two distinct pools within the top-bank. For purposes of this report both "pools" below the controlling elevation were regarded as one pool in subsequent calculations. The surface area of Borrow Pit 21 is 9.2 acres, while the shoreline length is 4,545 feet. The maximum depth is 3.5 feet and the mean depth is 1.7 feet.

Three peninsulas, six islands, a traverse and other regular shoreline features form a longitudinal separation of high ground along the east side of the borrow pit. These areas support abundant woody vegetation, herbaceous cover, vines and understory. Woody vegetation surrounds the borrow pit and consists of American and slippery elms, silver maple, black willow, cottonwood, pin oak, bur oak, Shumard oak, and osage orange. Primary levee vegetation is tall fescue and native red clover.

The SDI for Borrow Pit 21 is 2.0, as compared with the average SDI of 2.2 for all borrow pits. Mean basin slope is 0.02 percent and is indicative of the generally shallow, gently-sloping character of the borrow pit's bottom. The first contour interval measured a 0.04 percent slope but is influenced by the generally steeper slope of the wooded island and peninsula strung along the east side of the borrow pit.

Borrow Pit 21 floods an average of 24 days per year as compared with an average of 84 days per year for all borrow pits. The pit does not flood every year. Between 1973 and 1981, Borrow Pit 21 flooded six of nine possible times.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>22</u>	River Mile	<u>315</u>	Percent Days Flooded	<u>18</u>
Bank (Left/Right)	<u>Right</u>	Volume	<u>71,813</u>	Shore Development Index	<u>2.6</u>
Max. Depth	<u>17.7</u>	Mean Depth	<u>7.2</u>	Mean Basin Slope	<u>0.14</u>
Control Elevation	<u>47.0</u>	Surface Area	<u>6.7</u>	Volume Development Index	<u>1.2</u>
Shoreline Length	<u>4947</u>	Average Days Flooded	<u>65</u>	Nearness to River	<u>0.4</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	153	42	46.0-47.0	0.758	4946.8	0.15
74	140	38	45.0-46.0	0.430	4718.7	0.25
75	102	28	44.0-45.0	0.612	4557.5	0.17
76	0	0	43.0-44.0	0.560	4345.2	0.16
77	1	0.3	42.0-43.0	0.426	3551.0	0.19
78	43	12	41.0-42.0	0.446	3549.2	0.16
79	109	30	40.0-41.0	0.427	2817.6	0.14
80*	40	"	39.0-40.0	0.445	2359.4	0.14
81	0	0	38.0-39.0	0.404	2885.8	0.17
			37.0-38.0	0.440	3007.4	0.14
			36.0-37.0	0.456	2481.0	0.11
			35.0-36.0	0.366	1849.6	0.11
			34.0-35.0	0.460	1791.4	0.07
			33.0-34.0	0.193	1160.9	0.11
			32.0-33.0	0.173	713.6	0.08
			31.0-32.0	0.095	431.6	0.07
			30.0-31.0	0.028	136.6	0.09
			30.0-Below	0.006	77.7	

Date Sampled: 29 July 1981 Time Sampled: 1600

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		<u>X</u>
	<u>A</u>	<u>B</u>	<u>A</u>	<u>E</u>	<u>A</u>	<u>B</u>	
DO	9.0	9.6	9.1	8.9	9.4	8.7	9.1
DO Saturation	122	130	123	121	128	119	124
pH	8.6	8.6	8.5	8.6	8.6	8.5	
ORP	295	285	280	259	285	222	271
Conductivity	220	220	225	219	220	220	221
Temperature	32.5	32.0	32.5	32.5	32.5	33.0	32.5
Turbidity			17.0				17.0
Secchi Disc	0.4	0.5	0.5	0.5	0.5	0.5	0.5
Sediment Percent V.R.	4.2	3.5	4.1	5.0	2.8	3.5	3.9

*Flooding data prior to 1980 is conceptual. Borrow pit was dug in 1979.

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 22

Water Quality Data, Subsurface

<u>Location/Parameter</u>	<u>Depth</u>	<u>DO</u>		<u>pH</u>	<u>ORP</u>	<u>Cond.</u>	<u>Temp.</u>
		<u>DO</u>	<u>Saturation</u>				
A2	2.0	5.4	72	8.3	260	230	31.5
A2	3.0	0.1	1	7.3	335	250	28.5
B2	2.0	6.5	87	8.4	261	221	31.5
B2	3.0	0.3	4	7.4	230	250	29.5

Grain Size Analysis

<u>Sieve Size</u>	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4					100.0	
6				100.0	99.5	
10				99.6	99.3	100.0
16			100.0	99.5	99.2	99.9
20			99.9	99.4	99.2	99.8
30	100.0		99.8	99.4	99.1	99.7
40	99.9		99.6	99.3	99.1	99.6
50	99.9		99.5	99.1	99.0	99.4
70	99.8	100.0	99.2	98.9	98.8	99.2
100	99.7	99.9	99.0	98.7	98.7	98.9
140	99.7	99.8	98.6	98.4	98.5	98.5
200	99.5	98.6	94.0	97.7	98.4	94.6
230	99.4	97.3	90.2	96.9	98.4	89.5

Narrative Description of Borrow Pit 22

Borrow Pit 22 is located in Concordia Parish, Louisiana, on the right bank of the Mississippi River at RM 315. The pit lies removed from the levee approximately 300 feet and is positioned at 0.4 miles from the river at the terminal end of a spur levee and southeast of Levee Station 256. The borrow pit was excavated in 1979 and contains three interconnected cells and a highly convoluted shoreline. The surface area of Borrow Pit 22 is 6.7 acres with a shoreline length of 4,947 feet. The maximum depth is 17.7 feet while the mean depth is 7.2 feet. This borrow pit was the deepest borrow pit recorded during this survey and showed the greatest mean depth.

Woody vegetation and trees surround the pit, however, it grows in small scattered stands. Other vegetation consists of numerous herbaceous species and abundant grasses. Primary woody vegetation consists of sweetgum, Nuttall oak, overcup oak, American sycamore, American elm, Eastern cottonwood, green ash, water oak, and others. Abundant grasses include Bermuda and Johnson grass, while the most common herbaceous plants include cocklebur, sedges, false nettle, ragweed, and others.

The SDI for Borrow Pit 22 was 2.6, higher than the average of 2.2 for all borrow pits. Mean basin slope was 0.14 percent, the steepest mean basin slope for all borrow pits. Individual contours varied in slope from a low of 0.07 percent slope at the 13 and 15 foot contours, to 0.25 percent slope at the 2-foot contour.

Borrow Pit 22 was flooded only once in 1980 for an estimated 11 days prior to biological sampling and topographical mapping. This borrow pit could be expected to flood an average of 65 days per year as compared with the average 84 days per year for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>23</u>	River Mile	<u>720</u>	Percent Days Flooded	<u>31</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>76,025</u>	Shore Development Index	<u>2.5</u>
Max. Depth	<u>6.2</u>	Mean Depth	<u>2.8</u>	Mean Basin Slope	<u>0.03</u>
Control Elevation	<u>195.0</u>	Surface Area	<u>17.7</u>	Volume Development Index	<u>1.4</u>
Shoreline Length	<u>7851</u>	Average Days Flooded	<u>115</u>	Nearness to River	<u>1.0</u>
Relative Location	<u>Concave</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	195	53	194.0-195.0	2.614	7851.4	0.07
74	185	51	193.0-194.0	5.496	7747.3	0.03
75	148	41	192.0-193.0	2.639	5443.7	0.05
76	70	19	191.0-192.0	2.294	4947.1	0.04
77	69	19	190.0-191.0	2.940	2828.6	0.02
78	113	31	189.0-190.0	1.673	1237.2	0.01
79	151	41	189.0-Below	0.085	226.5	
80	52	14				
81	50	14				

Date Sampled: 31 July 1981 Time Sampled: 1615

Water Quality Data, Surface

Parameter	Leveeward		Location Open Water		Riverward		\bar{X}	
	A	B	A	B	A	B		
DO				8.0				
DO Saturation				102				
pH	8.3	8.0	8.2	7.9	8.1	8.1		
ORP	325	330	345	340	350	340	338	
Conductivity	390	360	390	360	390	380	378	
Temperature	30.0	29.0	29.0	28.0	28.5	28.5	28.8	
Turbidity			11.0	9.0			10.0	
Secchi Disc	0.4	0.5	0.4	0.5	0.4	0.5	0.5	
Sediment Percent V.R.	4.4	5.5	5.9	5.8	4.3	4.3	5.0	

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 23

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
1						100.0
4						90.5
6						90.1
10						89.2
16	100.0		100.0			88.9
20	99.5		99.9			88.5
30	99.4		99.8		100.0	88.4
40	99.1		99.8	100.0	99.9	88.1
50	98.8		99.7	99.9	99.9	87.8
70	98.6		99.6	99.9	99.7	87.7
100	98.5	100.0	99.5	99.7	99.7	87.5
140	98.3	99.8	99.2	99.7	99.6	87.2
200	98.0	99.8	98.9	99.4	99.3	86.6
230	97.9	99.8	98.9	99.3	99.3	86.5

Narrative Description of Borrow Pit 23

Borrow Pit 23 is located in Shelby County, Tennessee, on the left bank of the Mississippi River at RM 720. The borrow pit is located in the corporate limits of the City of Memphis, Tennessee, and is connected by a 24 inch culvert to a floodplain lake known locally as Cockle Burr Lake. The borrow pit is located 500 feet from the toe of the levee and is approximately 1.0 mile from the Mississippi River. The borrow pit has a highly convoluted shoreline, including peninsulas and islands, and is composed of five distinct yet interconnected ponds. The surface area of Borrow Pit 23 is 17.7 acres with a shoreline length of 7,851 feet. The maximum depth is 6.2 feet while the mean depth is 2.8 feet.

Borrow Pit 23 is completely surrounded by trees. The primary woody vegetation is black willow and rose mallow with a mixture of bald cypress, American sycamore, Eastern cottonwood, bur oak, overcup oak, Nuttall oak, water oak, silver maple, and others. Vines and understory are generally dense in the wooded areas, while the shallow water areas support heavy growths of pondweed.

The SDI for the borrow pit was 2.5, higher than the average SDI of 2.2 for all borrow pits. Mean basin slope was 0.03 percent.

Bottom sediments were approximately 99 percent silt-clay with the exception of the downstream, riverward station which was 86.5 percent silt-clay. Volatile residue was less than 6 percent at all stations, and ranged from a low of 4.3 percent at the two riverward stations to a high of 5.9 percent in the openwater location. Borrow Pit 23 floods an average of 115 days annually compared with the average days flooded for all borrow pits of 84 days.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>24</u>	River Mile	<u>151</u>	Percent Days Flooded	<u>32</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>149,314</u>	Shore Development Index	<u>3.1</u>
Max. Depth	<u>7.5</u>	Mean Depth	<u>4.3</u>	Mean Basin Slope	<u>0.06</u>
Control Elevation	<u>14.0</u>	Surface Area	<u>22.1</u>	Volume Development Index	<u>1.7</u>
Shoreline Length	<u>10,796</u>	Average Days Flooded	<u>117</u>	Nearness to River	<u>0.1</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	220	60	13.0-14.0	2.101	10,796.3	0.12
74	190	52	12.0-13.0	1.868	10,410.9	0.13
75	161	44	11.0-12.0	2.291	10,250.8	0.10
76	44	12	10.0-11.0	2.443	9,825.6	0.09
77	65	18	9.0-10.0	3.982	9,377.2	0.05
78	105	29	8.0- 9.0	4.939	7,742.0	0.03
79	174	48	7.0- 8.0	3.965	5,164.9	0.02
80	53	15	7.0-Below	0.508	1,726.0	
81	39	11				

Date Sampled: 5 August 1981 Time Sampled: 1200

Water Quality Data, Surface

Parameter	Quality Data Surface							
	Leveeward		Location Open Water		Riverward		\bar{X}	
	A	B	A	B*	A	B*		
DO	5.5	6.1	5.4	3.7	5.6	3.3	4.9	
DO Saturation	74	81	72	49	75	44	66	
pH	7.9	7.9	7.8	7.7	7.7	7.7		
ORP	279	289	310	279	315	279	292	
Conductivity	453	449	430	449	431	449	444	
Temperature	31.5	31.2	31.0	30.5	31.0	30.5	31.0	
Turbidity			16.0	22.0			19.0	
Secchi Disc	0.2	0.1	0.2	0.2	0.2	0.2	0.2	
Sediment Percent V.R.	4.9	3.3	4.5	4.0	5.0	5.0	4.5	

*These stations were sampled following a 2-hour rain.

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 24

<u>Sieve Size</u>	<u>Grain Size Analysis</u>					
	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6						
10						
16	100.0		100.0			
20	99.5		99.9		100.0	
30	99.3	100.0	99.8		99.9	
40	99.3	99.9	99.6	100.0	99.9	100.0
50	99.2	99.9	99.5	99.9	99.8	99.8
70	99.1	99.9	99.4	99.9	99.8	99.8
100	99.1	99.9	99.3	99.8	99.8	99.6
140	98.9	99.7	99.1	99.8	99.7	99.6
200	98.7	99.6	98.8	99.4	99.3	99.4
230	98.5	99.6	98.7	99.1	99.2	99.2

Narrative Description of Borrow Pit 24

Borrow Pit 24 is located in St. James Parish, Louisiana, adjacent to the levee on the left bank of the Mississippi River at RM 151 between Levee Stations 3944 and 4000. The borrow pit lies adjacent to the levee and is less than 500 feet from the Mississippi River. Borrow Pit 24 is approximately 0.9 miles long and approximately 225 feet wide at its widest point. It has a surface area of 22.1 acres and a shoreline length of 10,796 feet. The maximum depth is 7.5 feet while the mean depth is 4.3 feet.

The borrow pit is surrounded by a fringe of black willow, with occasional Eastern cottonwood, American sycamore, roughleaf dogwood, box elder, and others. Swamp privet is common leveeward, while vines and understory are dense on all sides except on the west side where an access road crosses the pit. Levee grasses are primarily Bermuda and Dallis grass.

The SDI for Borrow Pit 24 was 3.1, greater than the average SDI of 2.2 for all borrow pits, and reflected the elongated, narrow morphology of the pit. Mean basin slope was 0.06 percent with the first four contours ranging from 0.09 percent to 0.13 percent slope.

Bottom sediments were consistently very fine throughout the borrow pit with all stations indicating greater than 98 percent silt-clay. Likewise, volatile residue was fairly consistent, ranging from a low of 3.3 percent to a high of 5.0 percent. Borrow Pit 24 floods every year, an average of 117 days per year, which is greater than the average of 84 days flooded per year for all borrow pits.

MISSISSIPPI RIVER LEVEE BORROW PIT INVESTIGATION
PHYSICAL CHARACTERIZATION DATA

Pit Number	<u>25</u>	River Mile	<u>180</u>	Percent Days Flooded	<u>22</u>
Bank (Left/Right)	<u>Left</u>	Volume	<u>325,348</u>	Shore Development Index	<u>3.4</u>
Max. Depth	<u>10.3</u>	Mean Depth	<u>5.6</u>	Mean Basin Slope	<u>0.07</u>
Control Elevation	<u>21.0</u>	Surface Area	<u>36.9</u>	Volume Development Index	<u>1.6</u>
Shoreline Length	<u>15,225</u>	Average Days Flooded	<u>81</u>	Nearness to River	<u>0.1</u>
Relative Location	<u>Straight</u>				

Year	Days Flooded	Percent of Yr. Flooded	Contour Interval	Acres within Contour Interval	Length of Upper Contour	Slope between Contours
73	156	43	20.0-21.0	2.462	15,224.5	0.14
74	155	43	19.0-20.0	3.676	15,511.0	0.10
75	136	37	18.0-19.0	3.395	15,440.0	0.10
76	8	2	17.0-18.0	2.659	14,040.7	0.12
77	9	3	16.0-17.0	2.857	12,708.0	0.10
78	65	18	15.0-16.0	2.946	12,097.3	0.09
79	136	37	14.0-15.0	4.365	11,752.1	0.06
80	46	13	13.0-14.0	6.514	11,443.6	0.03
81	16	4	12.0-13.0	5.160	7,916.7	0.03
			11.0-12.0	2.340	3,442.2	0.02
			11.0-Below	0.473	1,054.7	

Date Sampled: 4 August 1961 Time Sampled: 1745

Water Quality Data, Surface

Parameter:	Location						
	Leveeward		Open Water		Riverward		
	A	B	A	B	A	B	X
DO*	5.7	5.4	5.3	5.3	5.3	4.0	5.2
DO Saturation	78	73	72	71	72	58	71
pH	8.1	7.8	8.2	7.9	7.9	7.6	
ORP	270	260	280	270	270	270	270
Conductivity	335	335	335	335	335	340	336
Temperature	32.5	32.5	32.5	32.5	32.5	32.0	32.4
Turbidity			11.0	9.0			10.0
Secchi Disc	0.3	0.3	0.3	0.4	0.3	0.3	0.3
Sediment Percent W.R.	2.5	3.2	3.8	3.4	4.0	0.4	3.0

*DO taken at 0800.

MISSISSIPPI RIVER BORROW PIT STUDY
PHYSICAL CHARACTERIZATION DATA

Borrow Pit Number 25

Water Quality Data, Subsurface

<u>Location/Parameter</u>	<u>Depth</u>	<u>DO</u>	<u>DO</u>		<u>pH</u>	<u>ORP</u>	<u>Cond.</u>	<u>Temp.</u>
			<u>Saturation</u>					
A2	1.7	5.8	78		8.0	260	340	32.0
B2	1.9	5.5	73		7.2	210	340	30.5

Grain Size Analysis

<u>Sieve Size</u>	<u>Upstream</u>			<u>Downstream</u>		
	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>	<u>Leveeward</u>	<u>Midpoint</u>	<u>Riverward</u>
4						
6						
10				100.0		
16				99.9		100.0
20				99.9		99.9
30	100.0			99.9		99.9
40	99.9	100.0	100.0	99.9		99.8
50	99.8	99.9	99.9	99.9		99.8
70	99.7	99.8	99.9	99.8	100.0	99.8
100	99.6	99.8	99.9	99.7	99.8	99.7
140	99.0	99.7	99.5	99.7	99.8	99.6
200	95.2	98.5	96.3	99.2	98.9	99.3
230	92.4	98.1	94.6	99.0	98.6	99.1

Narrative Description of Borrow Pit 25

Borrow Pit 25 is located in Ascension Parish, Louisiana, on the left bank of the Mississippi River at RM 180, between Levee Stations 2613 and 2535. The borrow pit is situated on 81 Mile Point, and is approximately 0.1 miles from the river. The borrow pit parallels, and is immediately adjacent to the levee for a distance of approximately 1.5 miles. Borrow Pit 25 is only 200 feet wide throughout its entire length. The surface area of the borrow pit is 36.9 acres with a shoreline length of 15,225 feet. The maximum depth is 10.3 feet while mean depth is 5.6 feet.

This long, narrow basin is surrounded by a fringe of trees, predominately black willow. Other woody vegetation includes Eastern cottonwood, American sycamore, box elder, bald cypress, wax myrtle, and others. Swamp privet is commonly found in association with the black willow on the bank of the borrow pit. Vines and understory are abundant. Duckweed was common on the downstream end of the borrow pit during the summer. Primary levee grasses are Bermuda and Dallis grass.

The SDI for this pit is 3.4 and reflects the relationship of its extreme length to narrow width. This borrow pit exhibited the second greatest SDI for all borrow pits, the average of which was 2.2. The mean basin slope for this borrow pit was 0.07 percent, with the first six 1-foot contours ranging from 0.09 percent slope to 0.14 percent slope.

Bottom sediments were greater than 92 percent silt-clay, with the more coarse sediments located on the upstream sampling stations. Volatile residue was low for the entire pit and varied from 2.5 percent volatile residue at the upstream levee station to 4.4 percent at the downstream riverward station. Borrow Pit 25 floods every year an average of 81 days per year, near the average of 84 days per year for all borrow pits.

APPENDIX B:

SCIENTIFIC AND COMMON NAMES OF PLANTS AND
THEIR PRESENCE/ABSENCE AT BORROW PITS
ALONG THE LOWER MISSISSIPPI RIVER

Table B1

Scientific and Common Names of Plants Occurring at the 25 Borrow Pits along
the Lower Mississippi River System, 1981-1983 (Based on Landin 1985)

Scientific Name	Common Name
<i>Acalypha gracilens</i>	Slender copperleaf
<i>Acalypha rhomboidea</i>	Three-seeded mercury
<i>Acer barbatum</i>	Florida maple
<i>Acer negundo</i>	Boxelder
<i>Acer rubrum</i>	Red maple
<i>Acer saccharinum</i>	Silver maple
<i>Acnida fasciculata</i>	Water hemp
<i>Agrostis gigantea</i>	Redtop
<i>Albizia julibrissin</i>	Mimosa
<i>Allium canadense</i>	Wild onion
<i>Alsine media</i>	Chickweed
<i>Althernanthera philoxeroides</i>	Alligator weed
<i>Amaranthus cannabinus</i>	Water amaranth
<i>Amaranthus spinosus</i>	Spiny amaranth
<i>Amaranthus</i> spp.	Pigweeds
<i>Ambrosia artemisiifolia</i>	Common ragweed
<i>Ambrosia trifida</i>	Giant ragweed
<i>Ammannia coccinea</i>	Ammannia
<i>Ampelopsis arborea</i>	Peppervine
<i>Andropogon glomeratus</i>	Bushy beardgrass
<i>Andropogon virginicus</i>	Broom sedge
<i>Apios americana</i>	Wild bean
<i>Aralia spinosa</i>	Devil's walking stick
<i>Arundinaria gigantea</i>	Switch cane
<i>Asclepias incarnata</i>	Milkweed
<i>Aster dumosus</i>	Narrowleaf aster
<i>Aster simplex</i>	Marsh aster
<i>Aster</i> spp.	Asters
<i>Azolla caroliniana</i>	Azolla
<i>Berchemia scandens</i>	Supplejack
<i>Betula nigra</i>	River birch
<i>Bignonia capreolata</i>	Crossvine
<i>Boehmeria cylindrica</i>	Bog-hemp
<i>Boehmeria scabra</i>	False nettle
<i>Bromus tectorum</i>	Cheat grass
<i>Brunnichia cirrhosa</i>	Lady's ear drops
<i>Bumelia lycioides</i>	Buckthorn bumelia
<i>Campsis radicans</i>	Trumpet creeper
<i>Cardiospermum halicacabum</i>	Balloon-vine
<i>Carex</i> spp.	Sedges
<i>Carex stipata</i>	Awl-fruited sedge
<i>Carpinus caroliniana</i>	American hornbeam
<i>Carya aquatica</i>	Water hickory

(Continued)

(Sheet 1 of 6)

Table B1 (Continued)

Scientific Name	Common Name
<i>Carya cordiformis</i>	Bitternut hickory
<i>Carya illinoensis</i>	Pecan
<i>Carya laciniosa</i>	Shagbark hickory
<i>Cassia nictitans</i>	Partridge pea
<i>Cassia obtusifolia</i>	Sicklepod
<i>Celtis laevigata</i>	Sugarberry
<i>Cephalanthus occidentalis</i>	Buttonbush
<i>Cercis canadensis</i>	Eastern redbud
<i>Chamaelirium luteum</i>	Blue blazing star
<i>Chenopodium ambrosioides</i>	Lamb's quarters
<i>Chionanthus virginicus</i>	Fringetree
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium vulgare</i>	Thistle
<i>Cocculus carolinus</i>	Carolina moonseed
<i>Commelina diffusa</i>	Marsh dayflower
<i>Convolvulus sepium</i>	Tievine
<i>Cornus drummondii</i>	Roughleaf dogwood
<i>Cornus florida</i>	Flowering dogwood
<i>Croton capitatus</i>	Woolly croton
<i>Cucurbita pepo</i>	Smell melon
<i>Cuscuta obtusifolia</i>	Dodder
<i>Cynodon dactylon</i>	Bermuda grass
<i>Cyperus esculentus</i>	Chufa
<i>Cyperus rotundus</i>	Coco
<i>Cyperus</i> spp.	Nutsedges
<i>Cyrilla racemiflora</i>	Swamp cyrilla
<i>Daucus carota</i>	Wild carrot
<i>Desmodium tenuifolium</i>	Tick trefoil
<i>Digitaria ischaemum</i>	Small crabgrass
<i>Digitaria sanguinalis</i>	Large crabgrass
<i>Diodia virginiana</i>	Buttonweed
<i>Diospyros virginiana</i>	Persimmon
<i>Echinochloa crusgalli</i>	Barnyard grass
<i>Echinochloa walteri</i>	Browntop millet
<i>Eichhornia crassipes</i>	Water hyacinth
<i>Eleocharis</i> spp.	Spikerushes
<i>Eleusine indica</i>	Goosefoot grass
<i>Eragrostis hypnoides</i>	Smooth creeping love grass
<i>Erigeron annuus</i>	Daisy fleabane
<i>Erigeron</i> sp.	Fleabane
<i>Erythrina herbacea</i>	Coral bean
<i>Eupatorium coelestinum</i>	Mist flower
<i>Eupatorium compositifolium</i>	Dog fennel
<i>Fagus grandifolia</i>	American beech
<i>Festuca arundinacea</i>	Tall fescue

(Continued)

(Sheet 2 of 6)

Table B1 (Continued)

Scientific Name	Common Name
<i>Forestiera acuminata</i>	Swamp privet
<i>Fraxinus pennsylvanica</i>	Green ash
<i>Fraxinus profunda</i>	Pumpkin ash
<i>Galium obtusum</i>	Marsh bedstraw
<i>Geranium carolinianum</i>	Wild geranium
<i>Gleditsia aquatica</i>	Water locust
<i>Gleditsia triacanthos</i>	Honey locust
<i>Glycine max</i>	Soybean
<i>Hamamelis virginiana</i>	Witch hazel
<i>Helenium amarum</i>	Bitter sneezeweed
<i>Helianthus giganteus</i>	Giant sunflower
<i>Heliotropium indicum</i>	Turnsole
<i>Hepatica</i> spp.	Liverwort
<i>Heterotheca subaxillaris</i>	Camphorweed
<i>Hibiscus incanus</i>	Velvet-leaf rose mallow
<i>Hibiscus lanceolata</i>	Narrowleaf rose mallow
<i>Hibiscus militaris</i>	Halberd-leaf rose mallow
<i>Hibiscus moscheutos</i>	Swamp rose mallow
<i>Hibiscus palustris</i>	Marsh rose mallow
<i>Hibiscus</i> sp.	Ruffle-leaf rose mallow
<i>Hibiscus</i> spp.	Rose mallow
<i>Hibiscus syriacus</i>	Smooth-leaf rose mallow
<i>Hordeum jubatum</i>	Big foxtail grass
<i>Hydrocotyle verticillata</i>	Pennywort
<i>Hypericum nudiflorum</i>	Marsh St. John's wort
<i>Ilex decidua</i>	Deciduous holly
<i>Impatiens capensis</i>	Jewelweed
<i>Ipomoea purpurea</i>	Morning Glory
<i>Itea virginica</i>	False willow
<i>Iva annua</i>	Annual elder
<i>Juncus effusus</i>	Soft rush
<i>Juniperus virginiana</i>	Eastern red cedar
<i>Juglans nigra</i>	Black walnut
<i>Jussiaea repens</i>	Primrose
<i>Lactuca canadensis</i>	Wild lettuce
<i>Lanum amplexicaule</i>	Hen-bit
<i>Lathyrus palustris</i>	Marsh vetchling
<i>Leersia oryzoides</i>	Rice cutgrass
<i>Leersia virginica</i>	Cutgrass
<i>Lemna minor</i>	Duckweed
<i>Leptochloa filiformis</i>	Sprangletop
<i>Lespedeza</i> spp.	Lespedeza
<i>Lippia lanceolata</i>	Frogfruit
<i>Liquidambar styraciflua</i>	Sweetgum
<i>Lolium perenne</i>	Perennial rye

(Continued)

(Sheet 3 of 6)

Table B1 (Continued)

Scientific Name	Common Name
<i>Lonicera japonica</i>	Japanese noneysuckle
<i>Ludwigia glandulosa</i>	Water purslane
<i>Lysimachia ciliata</i>	Water loosestrife
<i>Maclura pomifera</i>	Osage orange
<i>Mentha spicata</i>	Mint
<i>Medicago arabica</i>	Spotted medic
<i>Melilotus officinalis</i>	Yellow sweet clover
<i>Mikania scandens</i>	Climbing hempweed
<i>Morus rubra</i>	Red mulberry
<i>Myrica cerifera</i>	Wax myrtle
<i>Nelumbo lutea</i>	Lotus
<i>Nymphaea odorata</i>	White water lily
<i>Nyssa aquatica</i>	Tupelogum
<i>Nyssa sylvatica</i>	Blackgum
<i>Orontium aquaticum</i>	Golden club
<i>Oxalis stricta</i>	Oxalis
<i>Panicum dichotomiflorum</i>	Spreading witchgrass
<i>Panicum paludivagum</i>	Water panic grass
<i>Panicum repens</i>	Torpedo grass
<i>Panicum spp.</i>	Panic grasses
<i>Panicum virgatum</i>	Switchgrass
<i>Parthenocissus quinquefolia</i>	Virginia creeper
<i>Paspalum boscianum</i>	Bull paspalum
<i>Paspalum dilatatum</i>	Dallis grass
<i>Paspalum distichum</i>	Knotgrass
<i>Paspalum notatum</i>	Bahia grass
<i>Paspalum urvillei</i>	Vasey grass
<i>Passiflora incarnata</i>	Maypop
<i>Phoradendron flavescens</i>	Mistletoe
<i>Physalis heterophylla</i>	Ground cherry
<i>Phytolacca americana</i>	Pokeberry
<i>Planera aquatica</i>	Planertree
<i>Plantago aquatica</i>	Plantain
<i>Platanus occidentalis</i>	American sycamore
<i>Polygonum coccineum</i>	Marsh smartweed
<i>Polygonum densiflorum</i>	Swamp smartweed
<i>Polygonum hydropiperoides</i>	Nodding smartweed
<i>Polygonum lapathifolium</i>	Big smartweed
<i>Polygonum pennsylvanicum</i>	Pennsylvania smartweed
<i>Polygonum persicaria</i>	Knotweed
<i>Polygonum punctatum</i>	Dotted smartweed
<i>Polygonum spp.</i>	Smartweeds
<i>Populus deltoides</i>	Eastern cottonwood
<i>Populus heterophylla</i>	Swamp cottonwood
<i>Potamogeton spp.</i>	Pondweeds

(Continued)

(Sheet 4 of 6)

Table B1 (Continued)

Scientific Name	Common Name
<i>Prunus americana</i>	American plum
<i>Prunus serotina</i>	Black cherry
<i>Quercus alba</i>	White oak
<i>Quercus lyrata</i>	Overcup oak
<i>Quercus macrocarpa</i>	Bur oak
<i>Quercus michauxii</i>	Swamp chestnut oak
<i>Quercus nigra</i>	Water oak
<i>Quercus nuttallii</i>	Nuttall oak
<i>Quercus palustris</i>	Pin oak
<i>Quercus phellos</i>	Willow oak
<i>Ranunculus repens</i>	Creeping buttercup
<i>Ranunculus septentrionalis</i>	Buttercup
<i>Rhus copallina</i>	Shining sumac
<i>Rhus radicans</i>	Poison ivy
<i>Rhynchospora corniculata</i>	Beak rush
<i>Rorippa sessiliflora</i>	Yellow cress
<i>Rosa virginiana</i>	Wild rose
<i>Rubus betulifolius</i>	Blackberry
<i>Rubus trivialis</i>	Southern dewberry
<i>Rudbeckia heliopsidis</i>	Black-eyed Susan
<i>Rudbeckia laciniata</i>	Cone flower
<i>Rumex crispus</i>	Curly-leaf dock
<i>Rumex</i> spp.	Dock
<i>Rumex verticillatus</i>	Swamp dock
<i>Sabal palmetto</i>	Palmetto
<i>Sagittaria latifolia</i>	Broadleaf arrowhead
<i>Salix interior</i>	Sandbar willow
<i>Salix nigra</i>	Black willow
<i>Sambucus canadensis</i>	American elderberry
<i>Sassafras albidum</i>	Sassafras
<i>Saururus cernuus</i>	Lizard's tail
<i>Schrankia microphylla</i>	Sensitive brier
<i>Scirpus hallii</i>	Dwarf bulrush
<i>Senecio glabellus</i>	Butterweed
<i>Senecio jacobaea</i>	Tansy
<i>Setaria geniculata</i>	Foxtail grass
<i>Setaria glauca</i>	Little foxtail grass
<i>Sicyos angulatus</i>	Bur cucumber
<i>Sida spinosa</i>	Prickly sida
<i>Sisyrinchium atlanticum</i>	Blue-eyed grass
<i>Smilax bona-nox</i>	Sow greenbrier
<i>Smilax hispida</i>	Fringe greenbrier
<i>Smilax laurifolia</i>	Laurel-leaf greenbrier
<i>Smilax rotundifolia</i>	Common greenbrier
<i>Solanum carolinense</i>	Horse nettle

(Continued)

(Sheet 5 of 6)

Table B1 (Concluded)

Scientific Name	Common Name
<i>Solanum torreyi</i>	Purple nightshade
<i>Solidago altissima</i>	Tall goldenrod
<i>Solidago canadensis</i>	Meadow goldenrod
<i>Solidago</i> spp.	Goldenrods
<i>Solanum carolinense</i>	Horse nettle
<i>Sonchus asper</i>	Saw thistle
<i>Sorghum halepense</i>	Johnson grass
<i>Sorghum vulgare</i>	Sorghum
<i>Spilanthes americana</i>	Creeping spot flower
<i>Spirodela polyrhiza</i>	Duckweed
<i>Sporobolus poiretii</i>	Smut grass
<i>Styrax americana</i>	Snowbell
<i>Symplocos tinctoria</i>	Common sweetleaf
<i>Taraxacum officinale</i>	Dandelion
<i>Taxodium distichum</i>	Bald cypress
<i>Tilia americana</i>	Basswood
<i>Tillandsia usneoides</i>	Spanish moss
<i>Trachelospermum difforme</i>	Vine starjasmine
<i>Trifolium agrarium</i>	Hop clover
<i>Trifolium incarnatum</i>	Crimson clover
<i>Trifolium pratense</i>	Native red clover
<i>Trifolium repens</i>	White Dutch clover
<i>Triticum aestivum</i>	Winter wheat
<i>Ulmus americana</i>	American elm
<i>Ulmus aquatica</i>	Water elm
<i>Ulmus rubra</i>	Slippery elm
<i>Urtica dioica</i>	Stinging nettle
<i>Vaccinium</i> sp.	Blueberry
<i>Vaccinium</i> spp.	Vaccinium
<i>Vernonia altissima</i>	Ironweed
<i>Verbena brasiliensis</i>	Wild verbena
<i>Vicia americana</i>	Common vetch
<i>Vicia lanceolata</i>	Narrowleaf vetch
<i>Viola</i> spp.	Violets
<i>Vitis aestivalis</i>	Summer grape
<i>Vitis riparia</i>	Riverbank grape
<i>Vitis rotundifolia</i>	Muscadine
<i>Vitis</i> spp.	Grapes
<i>Wisteria macrostachya</i>	Wisteria
<i>Wolffia columbiana</i>	Duckweed
<i>Xanthium strumarium</i>	Cocklebur
<i>Xyris iridifolia</i>	Yellow-eyed grass
<i>Yucca treculeana</i>	Yucca
<i>Zizania aquatica</i>	Wild rice

(Sheet 6 of 6)

Table B2

Plant Species occurring at the 25 Borrow Pits along the Lower Mississippi River Levee System, 1981-1983 (Landin 1985)

Plant Name (Alphabetized Within Groups)	Borrow Pits																									
	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	FP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25	
Grasses																										
Bahia grass	-	-	-	-	-	-	X	-	X	X	X	-	X	X	-	X	-	-	-	X	-	X	X	-	-	
Barnyard grass	-	X	-	-	X	-	X	-	-	-	X	-	-	-	X	-	-	-	-	X	-	X	X	-	-	
Bermuda grass	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Big foxtail grass	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-	X	-	-	-	
Broom sedge	-	-	-	X	-	-	-	X	-	X	-	X	-	X	X	X	X	-	X	X	X	X	-	-	X	
Browntop millet	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	
Bull paspalum	-	-	-	0	0	-	-	-	0	-	0	-	-	-	-	0	-	0	-	-	-	0	-	-	-	
Bushy beardgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	*	X	-	*	-	X	-	-	-	-	-	X	
Cheat grass	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	0	-	-	-	0	-	-	
Cutgrass	-	-	0	-	-	-	0	-	-	-	X	-	-	-	X	-	-	-	-	0	-	0	-	0	0	
Dallis grass	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	-	X	X	*	*	
Foxtail grass	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	
Goosefoot grass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	-	
Johnson grass	*	*	X	X	X	X	X	X	X	X	X	X	-	*	X	X	X	*	X	X	X	*	X	-	-	
Knotgrass	-	X	-	-	X	-	-	-	0	X	-	-	-	X	0	-	0	-	-	-	X	-	X	-	0	X
Large crabgrass	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

(Continued)

Occurrence codes: (-) = plant species does not occur at given pit; (0) = plant species rarely occurs at given pit;
 (x) = plant species commonly occurs at given pit; and (*) = plant species abundantly occurs at given pit.

Table E2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Grasses																									
Little foxtail grass	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Panic grasses	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Perennial rye	-	-	0	0	-	0	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Redtop	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	X	-	-	-	-	-	-
Rice cutgrass	-	-	-	-	0	0	0	0	-	0	X	X	-	-	0	-	-	0	-	-	-	-	X	0	-
Small crabgrass	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Smooth creeping lovegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smut grass	-	X	X	X	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	X	X
Sorghum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Sprangletop	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spreading witchgrass	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	X	X	-	X	-	X	X	X	X
Swamp sprangletop	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-
Switch cane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	X	-	0	-	-
Switchgrass	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-
Tall fescue	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-
Torpedo grass	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	0	0
Vasey grass	0	-	-	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	0	-	0	-	0	0	0
Water panic grass	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild rice	Z	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Winter wheat	0	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	X	-	X	-	-	-	-	-	-

(Continued)

(Sheet 2 of 15)

Table B2 (Continued)

Plant Name	Bottom Pits																							
	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24
Aquatic and Marsh																								
Alligator weed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Azolla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big smartweed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broadleaf arrowhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broadleaf cattail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bog-hemp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chufa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Creeping buttercup	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dotted smartweed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duckweeds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dwarf bulrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Golden club	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lemna	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liverwort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lizard's tail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lotus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marsh smartweed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nodding smartweed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mutsedges	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Continued)

(Sheet 3 of 15)

Table B2 (Continued)

Plant Name (Alphabetized Within Groups)	Borrow Pits																										
	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25		
Aquatic and Marsh																											
Pennywort																											
Pondweeds	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Sedges	-	-	X	X	X	-	-	-	X	-	X	-	X	-	X	-	X	-	X	X	X	X	-	-	X		
Smartweeds	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Soft rush	-	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Southern smartweed	X	X	X	X	X	X	-	-	-	-	X	X	-	-	X	-	X	-	X	-	X	-	X	-	X		
Spikerushes											X	X	-	X	X	-	X	*	X	-	X	X	-	*	*		
Spirodella	X	X		X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X	X	X		
Swamp smartweed	-	X	-	-	X	X	X	X	X	X	X	X	-	-	X	-	X	X	-	-	-	-	-	X	X		
Water hyacinth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Water hemp	X	-	-	-	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-	X	X	X	-	X		
Water purslane	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Water smartweed	-	-	-	-	-	-	-	-	-	-	X	-	-	*	X	X	X	X	X	X	X	X	X	X	X		
White water lily	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Wolffia	X	X	-	-	X	X	X	-	X	X	X	-	-	-	-	-	-	X	-	-	-	-	X	X	X		
Terrestrial																											
Ammaria											X	X	-	-	X	-	-	X	-	X	-	X	-	X	X		
Asters	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		
Awl-fruited sedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Annual elder	X	X	X	X	X	X	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

(Continued)

(Sheet 4 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Herbaceous																									
Beak rush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-
Bitter sneezeweed	-	X	*	X	X	-	X	X	X	X	X	X	*	-	X	-	*	-	-	-	-	-	X	X	-
Black-eyed Susan	X	-	X	-	-	-	-	X	-	X	X	-	-	-	X	X	X	X	-	X	-	X	X	X	X
Blue blazing star	-	O	-	-	O	-	O	O	O	O	O	-	-	-	-	-	-	O	O	O	O	O	O	-	-
Buttercup	-	X	X	-	X	X	X	*	X	-	X	-	X	X	-	-	-	-	-	-	X	-	-	-	-
Butterweed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Buttonweed	-	-	-	X	X	-	-	-	-	-	X	-	X	X	-	-	X	-	-	X	-	X	-	X	-
Camphorweed	-	O	-	-	O	O	O	O	O	-	O	-	O	O	O	-	O	-	-	-	O	-	O	-	-
Canada thistle	-	O	-	O	-	O	O	-	-	-	O	-	-	O	O	-	O	-	O	-	O	-	O	-	-
Chickweed	-	-	X	X	-	-	X	-	X	X	X	-	-	X	-	X	X	-	-	X	X	X	X	X	X
Cocklebur	X	X	*	X	X	X	X	X	X	X	X	X	X	*	X	*	X	*	*	X	X	*	*	X	X
Coco	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Common ragweed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Common vetch	X	X	X	-	-	X	-	-	-	-	-	-	-	X	-	X	X	X	X	X	X	X	-	-	X
Cone flower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-	X	-	X	-	O	-	-
Creeping spot flower	O	-	-	O	-	-	-	-	-	-	O	-	-	O	-	-	O	-	-	O	-	O	-	O	O
Crimson clover	-	O	O	O	O	O	O	-	-	-	-	-	-	-	-	-	-	-	O	-	O	-	O	-	O
Curly-leaf dock	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Daisy fleabane	-	-	-	O	-	-	-	O	-	-	-	O	-	O	-	-	O	-	X	-	X	-	O	-	-
Dandelion	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

(Continued)

(Sheet 5 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Herbaceous																									
Dock	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dog fennel	X	X	-	X	X	X	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X	X	X	-	-
False nettle	X	-	-	X	-	X	X	*	X	X	X	X	X	-	*	X	X	*	X	X	-	X	*	X	X
False willow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fleabane	-	-	-	-	-	-	O	-	-	-	O	-	-	-	-	O	-	O	-	-	O	-	-	-	-
Frogfruit	X	X	-	X	X	X	X	-	X	X	X	X	X	-	X	X	X	X	X	X	-	X	X	X	X
Giant ragweed	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	-	X	X	X	X	-	X	X	X	X
Giant sunflower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-	O	-	-	-	-
Goldenrods	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ground cherry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hen-bit	-	X	X	-	-	X	-	X	X	-	X	-	-	-	-	-	-	X	X	X	X	X	-	X	X
Hop clover	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	O	O	O	-	-	O	O
Horse nettle	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Ironweed	-	-	-	O	-	-	O	O	-	-	-	O	O	-	O	-	O	O	O	-	-	O	O	-	-
Jewelweed	-	-	-	O	-	-	O	-	-	-	O	-	-	-	O	-	-	O	O	-	-	O	-	X	-
Knotweed	O	-	-	O	O	-	O	-	-	-	-	X	-	-	-	-	X	-	X	O	X	O	X	O	X
Lamb's quarters	O	-	-	-	O	X	O	-	-	-	X	-	-	-	-	-	-	-	O	-	O	O	O	O	O
Lespedeza	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-	O	-	O	-	-	-	-
Marsh aster	-	-	-	X	-	X	X	X	X	-	X	-	-	-	-	-	X	X	-	-	X	X	X	X	X
Marsh bedstraw	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	X	X	-

(Continued)

(Sheet 6 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
(Alphabetized Within Groups)																									
Herbaceous																									
Marsh dayflower	-	x	-	x	x	x	x	-	x	x	x	x	-	-	-	x	x	-	x	x	-	x	x	x	x
Marsh vetchling	x	x	-	-	-	x	-	-	-	-	x	-	-	x	x	x	x	x	x	-	x	-	x	-	-
Maypop	-	o	-	o	o	o	o	-	-	o	-	-	-	-	-	-	-	-	-	o	-	o	-	o	o
Meadow goldenrod	-	-	-	-	-	-	-	-	o	-	x	-	x	-	-	-	x	-	x	-	-	-	-	-	-
Milkweed	-	-	-	o	-	o	-	-	-	o	-	-	-	o	-	-	o	-	x	-	-	-	-	-	-
Mint	-	-	-	-	-	-	o	-	-	o	-	-	-	-	-	-	x	-	x	-	-	-	-	-	-
Mist flower	-	x	-	-	-	x	-	x	-	x	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Mosses	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Narrowleaf aster	-	-	-	x	-	x	x	x	*	x	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Narrowleaf vetch	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Native red clover	-	-	-	-	-	-	-	-	-	-	x	x	-	-	x	x	-	-	-	-	-	-	-	-	-
Oxalis	-	-	-	o	-	-	o	-	-	-	o	-	-	-	-	o	-	o	-	o	o	o	o	o	o
Partridge pea	o	-	-	o	-	-	-	-	o	-	o	o	-	-	-	-	-	o	o	x	o	x	-	-	-
Pigweeds	x	x	x	x	x	x	x	x	x	-	x	x	x	-	x	x	x	-	x	x	x	x	x	x	x
Plantain	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Pokeberry	-	-	-	-	-	-	-	-	-	-	o	-	o	-	o	-	-	-	-	o	-	-	o	-	-
Prickly sida	x	x	x	x	x	x	x	x	x	x	x	x	x	-	x	x	-	x	-	x	-	x	x	x	x
Primrose	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purple nightshade	-	-	-	x	x	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-

(Continued)

(Sheet 7 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Herbaceous																									
Sensitive brier	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	-	X	X	X	-	X	-	X	X
Sicklepod	O	O	O	-	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-
Slender copperleaf	-	X	-	-	-	O	O	-	O	-	X	-	O	-	X	-	-	O	-	-	-	-	-	-	-
Sow thistle	-	X	X	X	X	-	X	X	X	X	X	X	X	-	-	X	X	-	-	-	-	-	X	-	X
Soybean	-	-	*	-	X	X	-	-	-	-	X	-	X	X	X	-	*	-	*	-	X	-	-	-	-
Spanish moss	O	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O
Spiny amaranth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-
Spotted medic	O	O	-	-	-	O	-	-	-	-	O	-	-	X	O	-	O	O	O	O	O	O	-	-	O
Stinging nettle	-	-	-	-	-	-	-	O	O	-	O	-	-	O	O	-	X	-	X	-	X	-	X	-	-
Swamp dock	-	X	-	X	-	-	X	-	X	-	X	-	-	-	-	-	-	-	-	X	-	X	-	X	X
Tall goldenrod	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	O	-	-	-	-
Tansy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	O	-	-	-	-
Thistle	O	O	-	O	O	O	-	-	O	-	O	O	O	O	O	O	O	O	O	-	O	O	-	-	-
Three-seeded mercury	-	-	-	-	-	X	X	-	X	X	X	-	-	-	X	-	-	-	-	-	-	X	-	X	-
Tick trefoil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-	-	-	X	-	-	-	-
Turnsole	O	O	-	-	-	O	O	-	O	O	-	-	O	-	O	-	-	-	-	-	-	-	-	-	O
Violets	-	-	-	O	-	-	O	-	-	-	O	-	-	-	O	-	X	-	X	-	X	O	O	-	-
Water amaranth	X	X	-	X	X	X	-	X	-	X	X	X	X	-	X	X	-	X	-	X	-	X	-	X	X
Water loosestrife	-	X	-	X	X	X	X	-	-	-	-	-	-	-	-	-	X	-	X	-	X	X	X	X	X
White Dutch clover	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

(Continued)

(Sheet 8 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Herbaceous																									
Wild bean	-	-	-	-	-	X	X	X	X	X	-	X	-	-	-	X	X	-	-	-	-	-	X	X	X
Wild carrot	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-	X
Wild geranium	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	-	-	*	-	-	X	-	X
Wild lettuce	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wild onion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild verbena	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	-	X	-	-	X	X	X
Woolly croton	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-	-	X	-	-
Yellow cress	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	-	-	X	X	X
Yellow-eyed grass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow sweet clover	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vines																									
Balloon-vine	X	X	-	X	X	X	X	-	X	-	X	X	-	-	-	X	-	X	-	-	-	X	X	X	X
Bur cucumber	X	X	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	X	X	X	X
Carolina moonseed	O	O	-	O	O	O	O	-	O	O	O	-	-	-	-	O	-	O	-	-	-	O	O	-	O
Climbing hempweed	X	X	-	X	X	X	X	X	X	X	X	X	-	-	X	-	-	X	X	*	-	X	X	X	X
Common greenbrier	O	X	-	X	X	O	X	X	X	O	X	O	X	X	X	O	X	X	O	X	O	X	X	X	X
Crossvine	X	X	-	X	X	X	X	-	X	X	X	X	-	-	-	-	-	X	-	-	-	X	X	-	X
Dodder	-	-	-	O	O	O	O	O	-	O	O	O	-	-	-	O	-	-	-	O	-	-	-	O	O
Fringe greenbrier	O	X	-	X	X	X	X	O	X	X	X	O	O	X	-	-	-	X	-	-	-	-	O	X	-
Grapes	X	X	-	X	X	X	X	-	X	X	X	X	X	X	X	-	-	X	-	-	-	X	X	X	X

(Continued)

(Sheet 9 of 15)

Table B2 (Continued)

Plant Name (Alphabetized Within Groups)	Borrow Pits																								
	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Vines																									
Japanese honeysuckle	X	-	-	-	-	X	X	X	X	-	X	-	-	-	-	-	X	-	-	-	X	-	X	-	-
Lady's ear drops	X	X	-	X	X	X	X	X	X	X	X	X	-	-	-	X	-	X	X	X	X	X	X	X	X
Laurel-leaf greenbrier	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Morning glory	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Muscadine	X	X	-	X	X	X	X	-	X	X	X	-	-	X	X	-	-	X	-	X	X	X	X	X	X
Peppervine	X	*	-	*	X	X	X	X	X	*	X	X	X	X	X	X	X	*	*	*	X	X	X	X	*
Poison ivy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Riverbank grape	-	-	-	-	-	-	-	X	X	-	X	-	X	X	X	-	X	-	X	-	X	-	X	-	-
Saw greenbrier	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X
Smell melon	X	-	X	X	-	X	X	-	-	-	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-
Summer grape	X	X	-	X	O	O	X	O	O	-	X	-	-	O	O	-	O	O	-	-	O	X	O	O	O
Supplejack	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tievine	X	X	*	X	X	X	X	X	X	X	X	-	-	-	X	-	X	X	X	X	X	X	X	X	X
Trumpet creeper	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-	X	X	X	X	-	X
Vine starjasmine	-	O	O	-	-	-	-	O	-	O	-	-	-	-	O	-	-	-	-	-	-	O	-	-	-
Virginia creeper	X	X	-	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X
Wisteria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Continued)

(Sheet 10 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Shrubs and Trees																									
American beech	-	0	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	0	-	0	-	-
American elderberry	0	-	-	0	-	-	-	-	-	-	X	-	-	-	-	0	-	X	-	X	0	X	0	0	0
American elm	X	X	-	X	X	X	X	X	X	X	X	X	X	0	X	-	X	-	X	X	X	X	X	X	X
American hornbeam	-	0	-	-	0	-	0	0	-	0	-	-	-	0	-	-	0	-	-	-	-	0	-	0	0
American plum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-
American sycamore	X	X	0	X	X	X	X	X	X	0	X	0	0	X	X	0	0	X	0	X	0	X	X	0	X
Bald cypress	0	0	0	0	0	0	0	-	-	0	X	0	-	0	0	-	X	X	-	0	0	0	0	-	0
Basswood	-	-	-	-	0	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
Bitternut hickory	-	X	-	X	X	X	X	-	X	-	X	-	X	X	X	-	X	X	-	X	-	X	X	0	X
Blackberry	-	X	-	0	-	-	-	-	-	-	X	-	0	X	-	-	X	-	X	-	X	-	X	-	-
Black cherry	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	0	
Blackgum	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	
Black walnut	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Black willow	X	*	X	*	*	X	*	X	*	*	X	*	*	*	*	X	X	*	*	*	*	*	*	*	*
Blueberry	-	-	-	-	-	-	-	0	-	-	0	-	-	0	-	-	-	-	-	-	0	-	-	-	-
Boxelder	X	X	-	X	X	X	X	X	X	X	X	X	X	-	0	X	-	0	X	-	X	0	X	X	X
Buckthorn bumelia	0	-	-	-	0	0	0	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Bur oak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	0	-	-
Buttonbush	0	X	0	X	0	X	X	-	-	-	X	-	-	-	X	-	X	X	-	X	X	-	0	0	X
Chinese tallow tree	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0

(Continued)

(Sheet 11 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Shrubs and Trees																									
Common sweetleaf	O	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coral bean	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-
Deciduous holly	X	*	-	X	X	X	*	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X
Devil's walking stick	-	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	O	-	-	O	-	-	-	-	-
Eastern cottonwood	X	*	O	*	X	X	X	X	X	X	X	X	X	X	X	X	O	X	*	X	X	X	X	X	X
Eastern redbud	-	O	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern red cedar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida maple	-	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-	-	-	-	-
Flowering dogwood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-
Fringetree	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green ash	X	X	-	X	X	X	X	X	X	-	X	X	X	X	X	-	X	-	X	X	X	X	X	O	X
Halberd-leaf rose mallow	O	X	O	X	X	X	-	X	X	-	X	-	X	X	X	-	-	-	O	-	-	X	X	-	-
Hawthorn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-
Honey locust	O	X	-	O	O	-	X	X	X	O	X	X	X	X	O	-	X	O	X	O	X	O	O	O	O
Live oak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O
Marsh rose mallow	O	O	-	X	X	O	X	O	X	O	X	O	-	O	-	-	-	*	X	-	X	-	*	-	-
Marsh St. John's wort	-	-	-	-	-	-	X	-	X	-	X	X	-	X	X	-	X	X	X	-	X	-	X	-	-
Mimosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	-
Mistletoe	-	X	-	X	X	O	O	-	-	-	X	-	-	-	-	-	X	O	-	-	-	X	X	-	X

(Continued)

(Sheet 12 of 15)

Table B2 (Continued)

Plant Name	Borrow Pits																								
(Alphabetized Within Groups)	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Shrubs and Trees																									
Narrowleaf rose mallow	-	-	-	-	-	-	x	-	x	-	x	-	-	-	x	-	x	-	-	-	x	-	-	-	-
Nuttall oak	-	x	-	x	x	o	o	o	o	-	x	o	-	x	o	-	o	-	-	-	x	o	-	-	o
Osage orange	-	-	-	x	x	-	x	x	x	x	x	x	x	x	x	-	x	-	*	-	*	-	x	-	-
Overcup oak	-	x	-	x	x	-	x	o	o	o	x	o	-	-	-	-	x	x	-	-	-	x	o	-	o
Palmetto	-	o	-	-	-	-	-	-	-	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-	o
Pecan	o	-	-	x	o	o	o	o	o	-	x	-	o	x	o	o	x	o	-	-	-	-	o	o	o
Persimmon	o	o	-	o	o	o	o	o	o	-	o	-	o	o	o	-	o	-	o	-	o	o	-	-	-
Pin oak	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-	o	-	o	-	x	-	o	-	-
Planertree	-	o	-	-	-	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	o
Pumpkin ash	-	o	-	-	-	-	o	-	-	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red maple	x	x	-	x	x	x	x	-	x	-	x	-	-	x	x	-	-	-	-	x	o	x	x	o	x
Red mulberry	-	o	-	-	-	-	-	-	-	-	o	-	-	-	o	-	o	-	-	-	x	-	-	-	-
River birch	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rose mallows	x	x	o	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	o	x	x	x	x	x	x
Roughleaf dogwood	x	x	-	x	x	x	x	-	x	x	x	x	-	-	x	x	x	x	x	x	-	x	x	x	x
Ruffle-leaf rose mallow	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sandbar willow	-	-	-	-	-	-	-	-	-	o	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-
Sassafras	-	-	-	-	-	-	-	-	-	-	-	-	o	-	o	-	o	-	-	-	x	-	-	-	-
Shellbark hickory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	o	-	-	o	-	o	-	-
Shining sumac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-

(Continued)

(Sheet 13 of 15)

Table B2 (Continued)

Plant Name (Alphabetized Within Groups)	Bottom Pits																								
	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Shrubs and Trees																									
Shumard oak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver maple	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slippery elm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smooth-leaf rose mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snowbell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southern dewberry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southern swamp dogwood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sugarberry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swamp chestnut oak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swamp cottonwood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swamp cyrilla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swamp privet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swamp rose mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sweetgum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tupelogram	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Velvet-leaf rose mallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

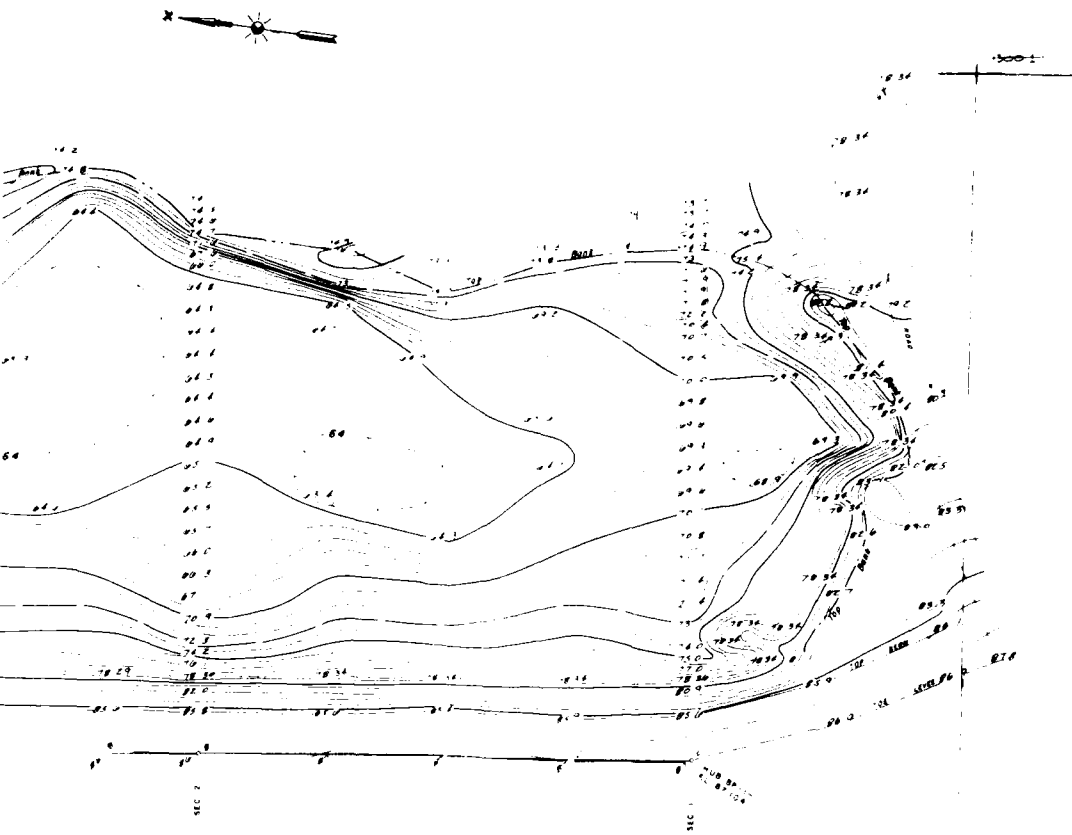
(Continued)

Table B2 (Concluded)

Plant Name (Alphabetized Within Groups)	Borrow Pits																								
	BP1	BP2	BP3	BP4	BP5	BP6	BP7	BP8	BP9	BP10	BP11	BP12	BP13	BP14	BP15	BP16	BP17	BP18	BP19	BP20	BP21	BP22	BP23	BP24	BP25
Shrubs and Trees																									
Water elm	-	o	-	-	o	-	-	-	-	-	o	-	o	-	o	-	-	-	-	-	-	o	-	-	-
Water hickory	o	o	-	x	-	-	o	o	-	-	o	-	-	-	o	-	o	o	-	o	-	o	-	-	o
Water locust	o	o	-	o	o	o	o	o	o	o	o	-	o	o	o	-	o	o	x	o	o	-	x	-	-
Water oak	-	o	-	o	o	-	o	-	-	-	o	-	o	-	-	-	-	-	-	-	-	o	o	o	o
Wax myrtle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	o
White oak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-
Wild rose	-	-	-	-	-	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-	-	o	-	-	-
Willow oak	-	o	-	o	o	-	o	-	o	o	x	-	-	x	-	-	-	-	-	o	x	o	x	o	o
Witch hazel	-	-	-	-	-	-	-	-	-	-	-	-	o	-	-	-	o	-	-	-	-	-	-	-	-
Yucca	-	o	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX C:

CONTOUR MAPS OF BORROW PITS ALONG
THE LOWER MISSISSIPPI RIVER



NOTE
TRAVERSE DATA BASED ON NEEDLE AZIMUTH

F B 28769

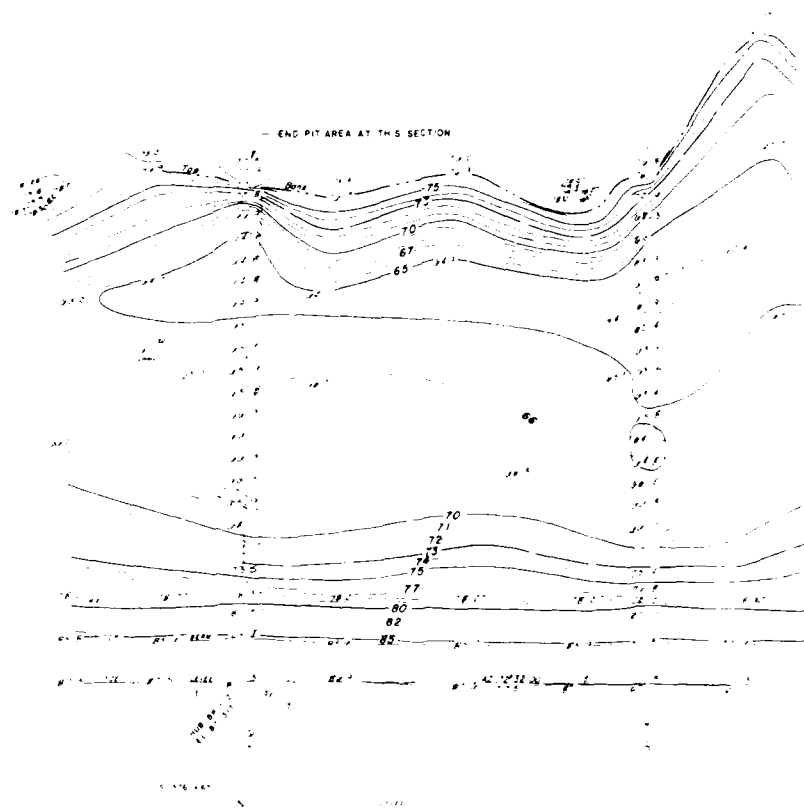
LEGEND

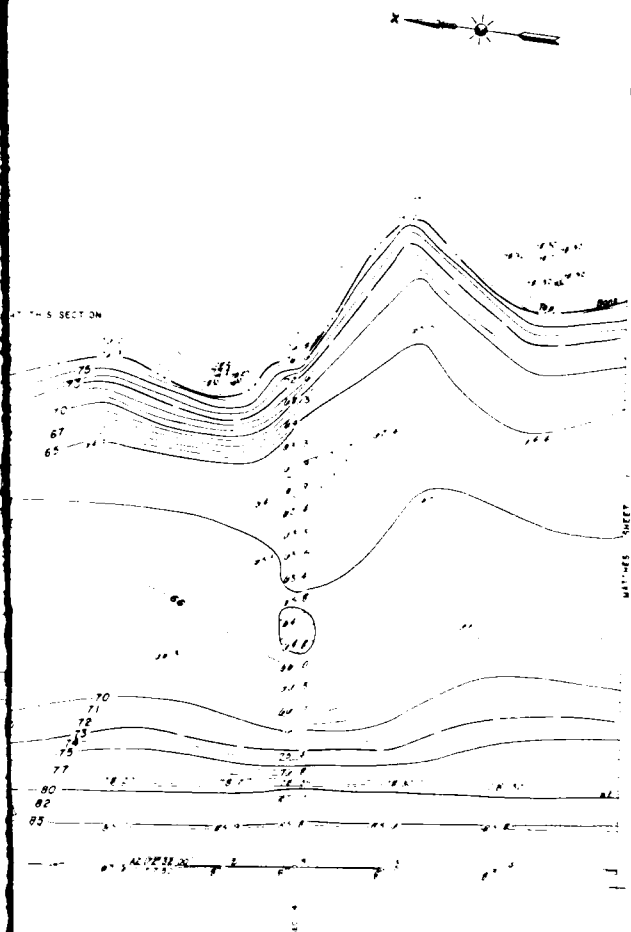
— CONTROLLING CONTOUR

MISSISSIPPI RIVER BASIN
EAST CARROLL PARISH, LOUISIANA
MISSISSIPPI RIVER BORROW PITS

IN 2 SHEETS
10 0 10 20 30 40 50 60 70 80 90 100
FEET
U. S. ARMY ENGINEER DISTRICT, VICKSBURG 1982
CORPS OF ENGINEERS
Prepared under the direction of
Col Samuel P. Collins, District Engineer.
Elevations in feet; heavy contour interval; 100 ft.
Surveyed by: G. L. BROWN, FOSTER & BROWN, DATE FEB 1982 FILE NO. E-2-14

PIT NO 1





NOTE
TRAVERSE DATA BASED ON NEEDLE AZIMUTH

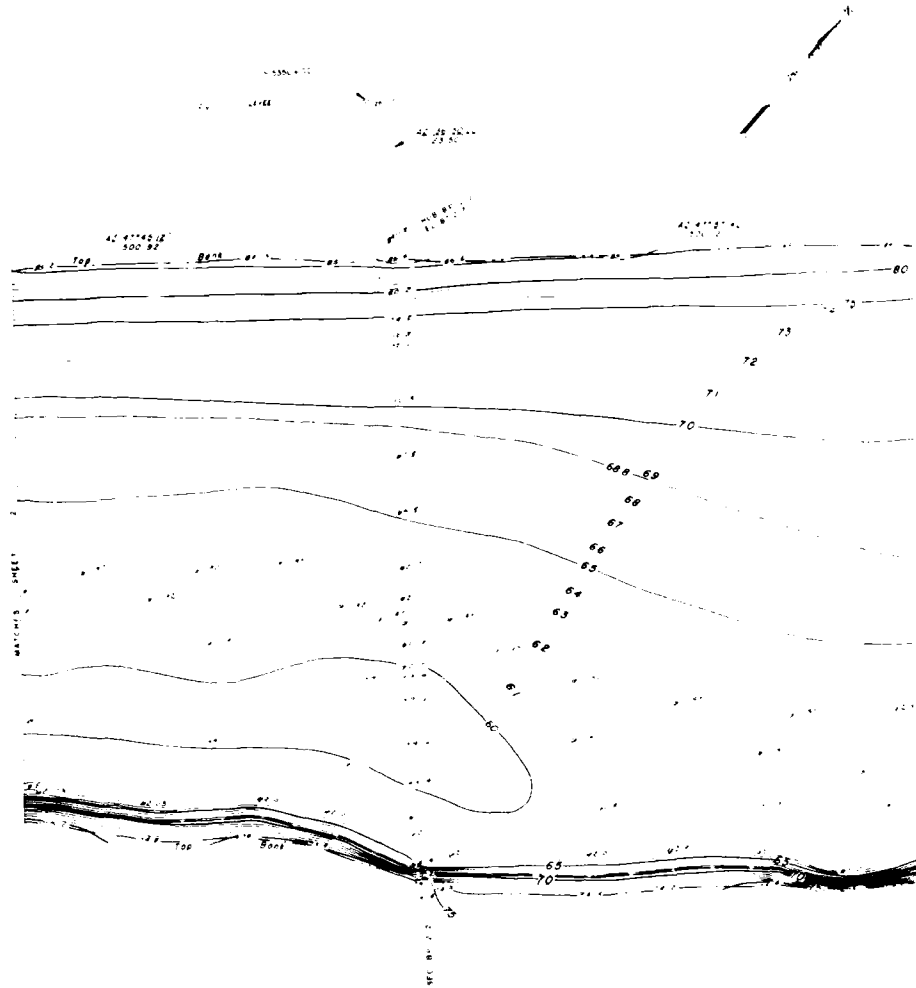
SEP 29 1964

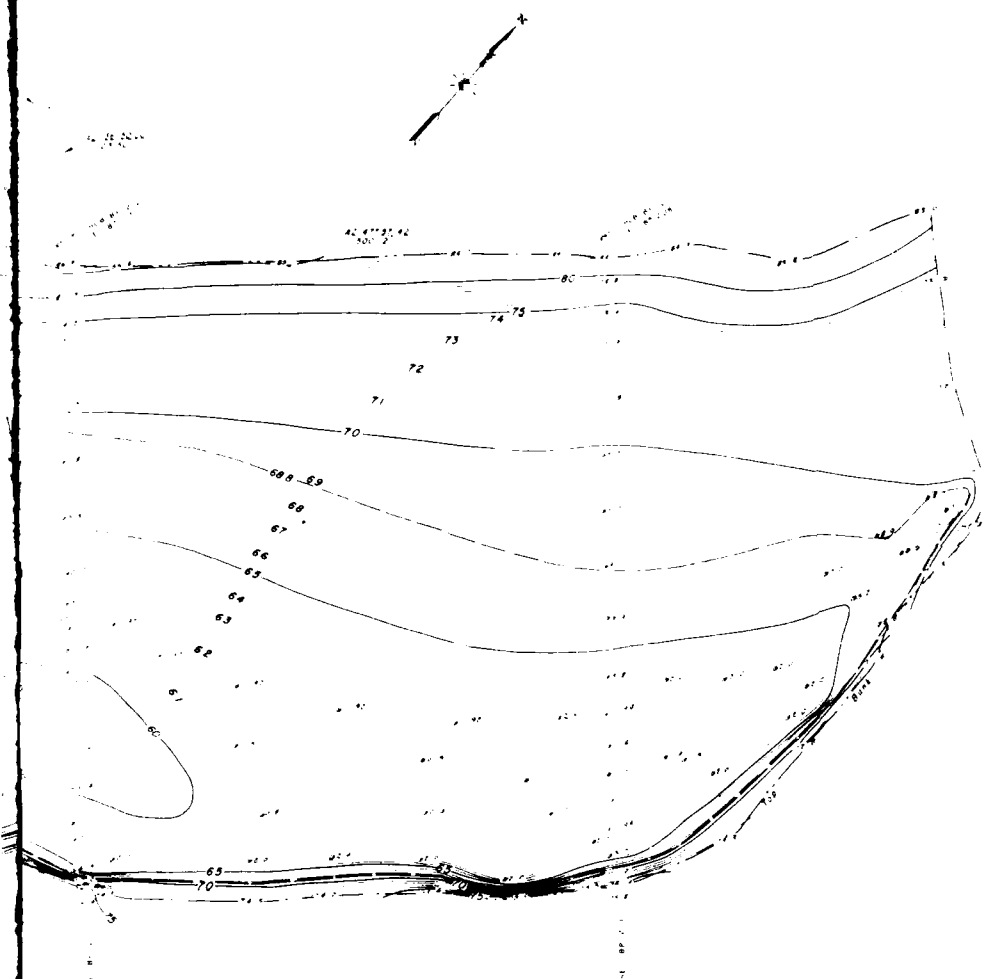
MISSISSIPPI RIVER BASIN
EAST CARROLL PARISH, LOUISIANA
MISSISSIPPI RIVER BORROW PITS

U S ARMY ENGINEER DISTRICT VICKSBURG 1962
CORPS OF ENGINEERS
Prepared under the direction of
Col Samuel P Collins, District Engineer

PIT NO. 1

CORPS OF ENGINEERS





NOTE
TRANSPOSE DATA BASED ON NEEDLE AZIMUTH

10-10-64

LEGEND
CONTROLLING CONTOUR

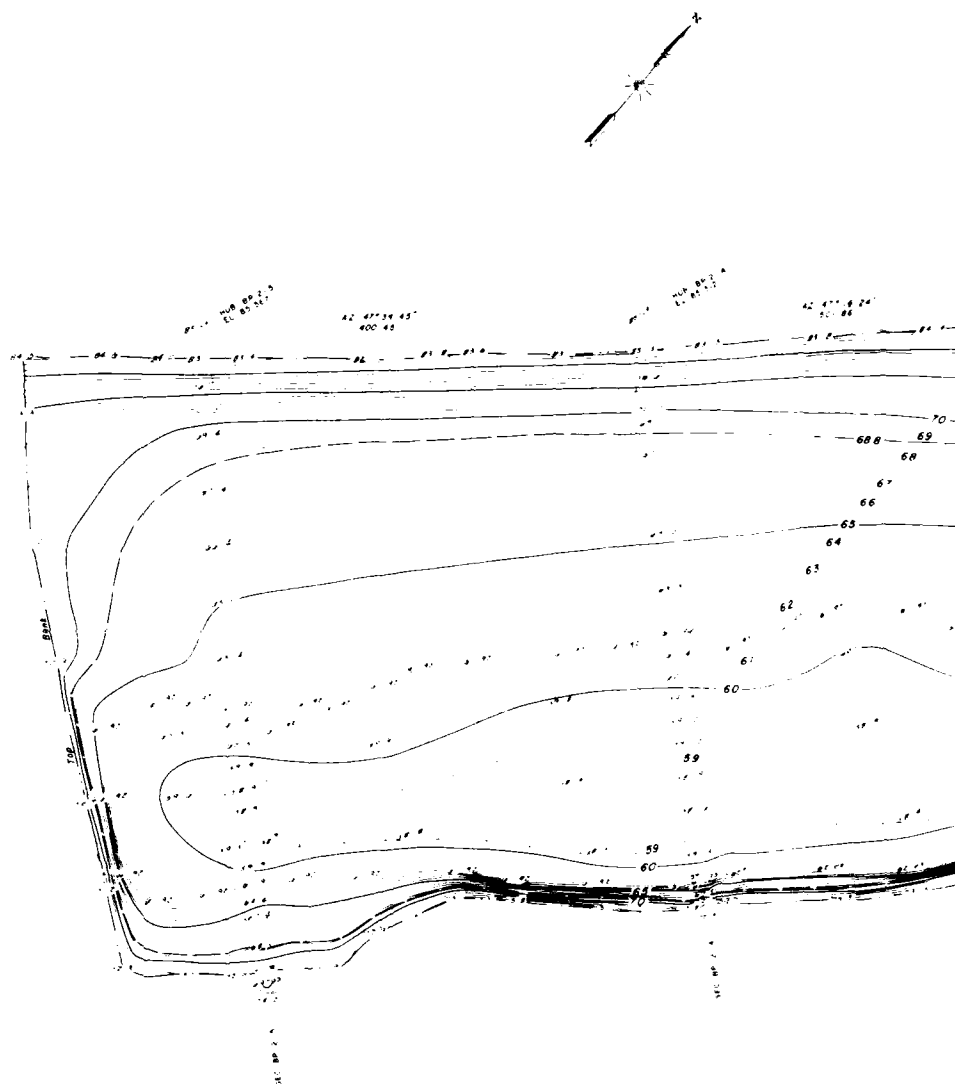
MISSISSIPPI RIVER BASIN
TENSAS PARISH, LOUISIANA
MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT VICKSBURG 1962
CORPS OF ENGINEERS
Prepared under the direction of
Col. Samuel P. Collins, District Engineer
ELEVATIONS IN FEET; HORIZONTAL CONTOUR INTERVAL, 1 FOOT
DRAWN BY: S. B. GALT (S-10000000) DATE FEB 1962

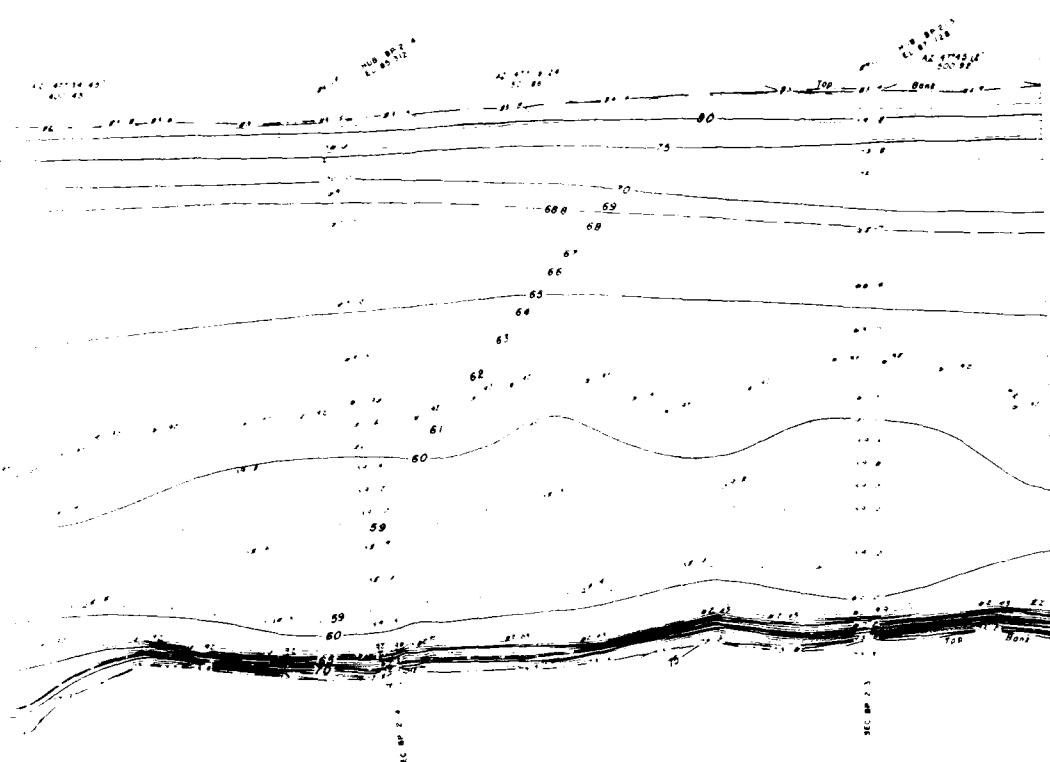
PIT NO 2

2

CORPS OF ENGINEERS



1



NOTE
TRAVERSE DATA BASED ON NECKE AZIMUTH

FD 2074

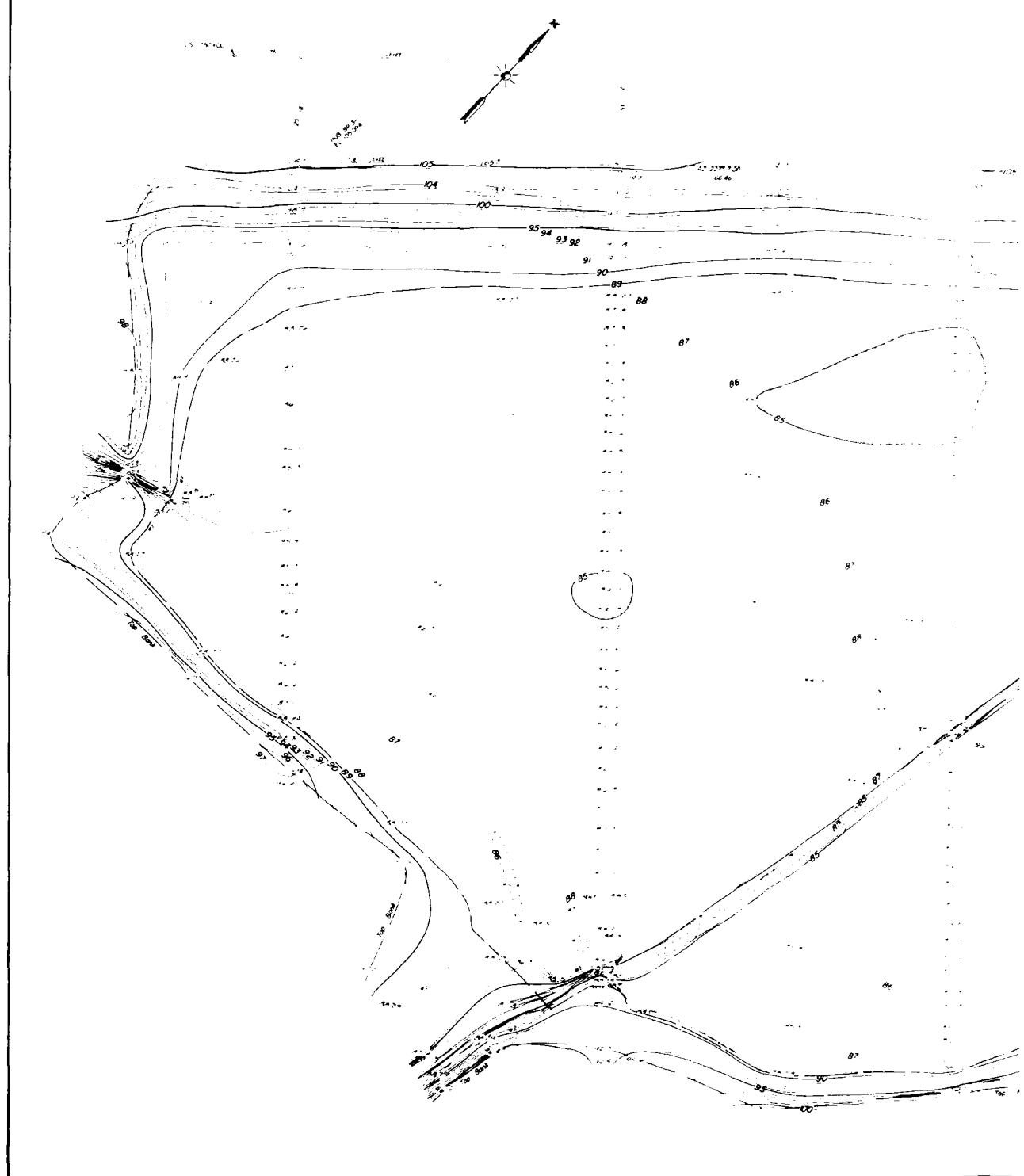
LEGEND
CONTROLLING CONTOUR

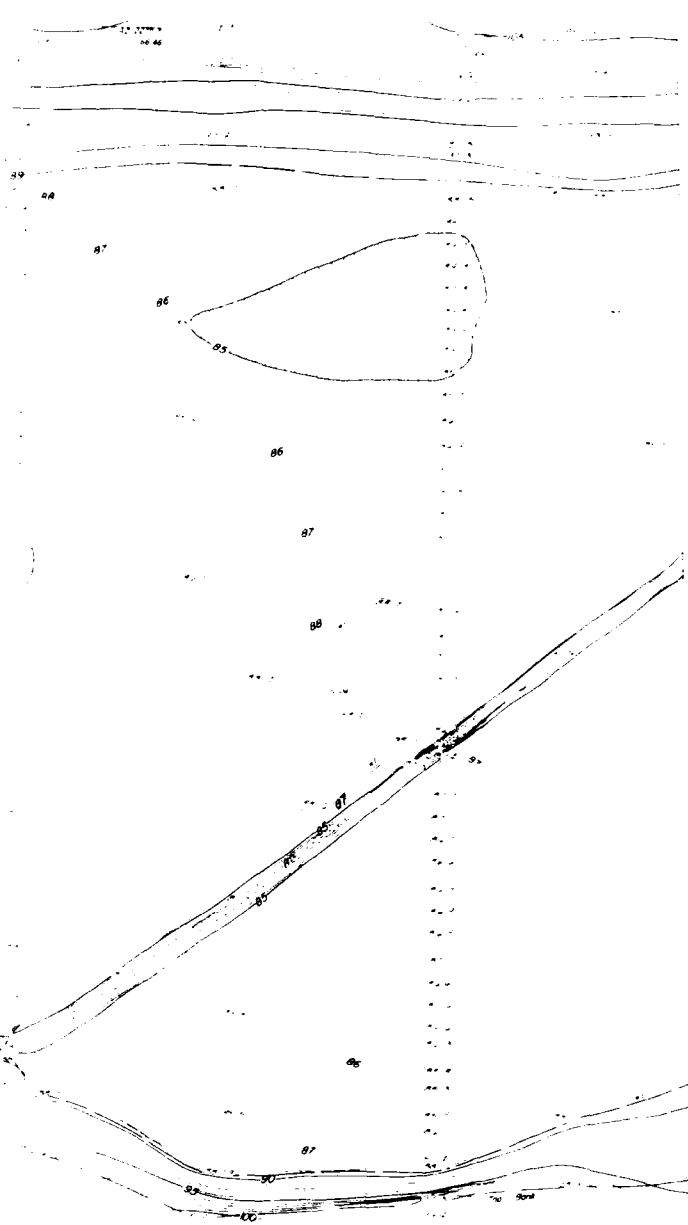
MISSISSIPPI RIVER BASIN
TENSAS PARISH, LOUISIANA
MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT VICKSBURG 1982
CORPS OF ENGINEERS
Prepared under the direction of
Col. Samuel P. Collins, District Engineer
ELEVATIONS IN FEET, HORIZONTAL DISTANCE IN FEET
DRAWN BY: DUREN, HOSKINS, DATE: FEB 1982

PIT NO 2

CORPS OF ENGINEERS





LEGEND

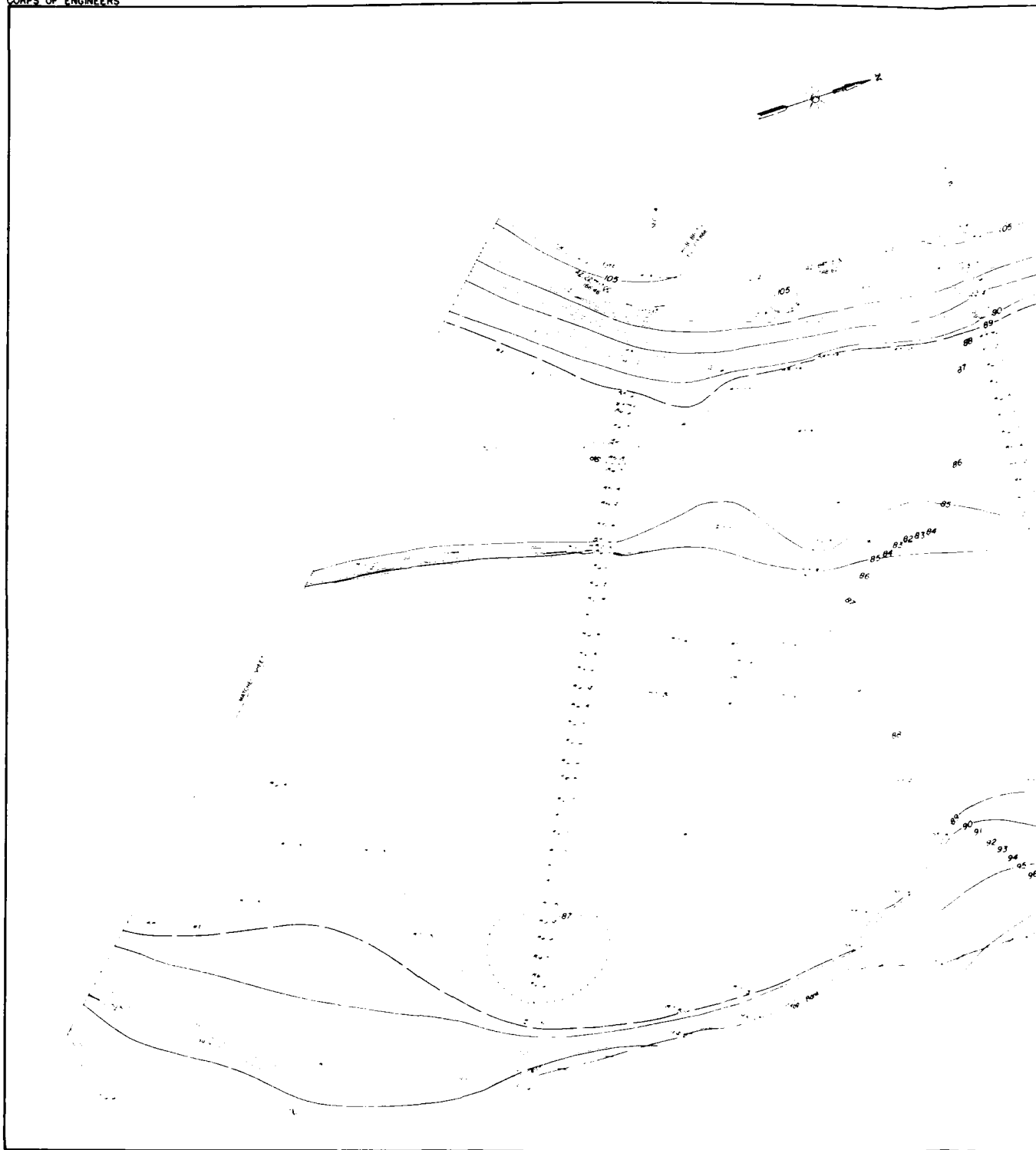
[illegible]

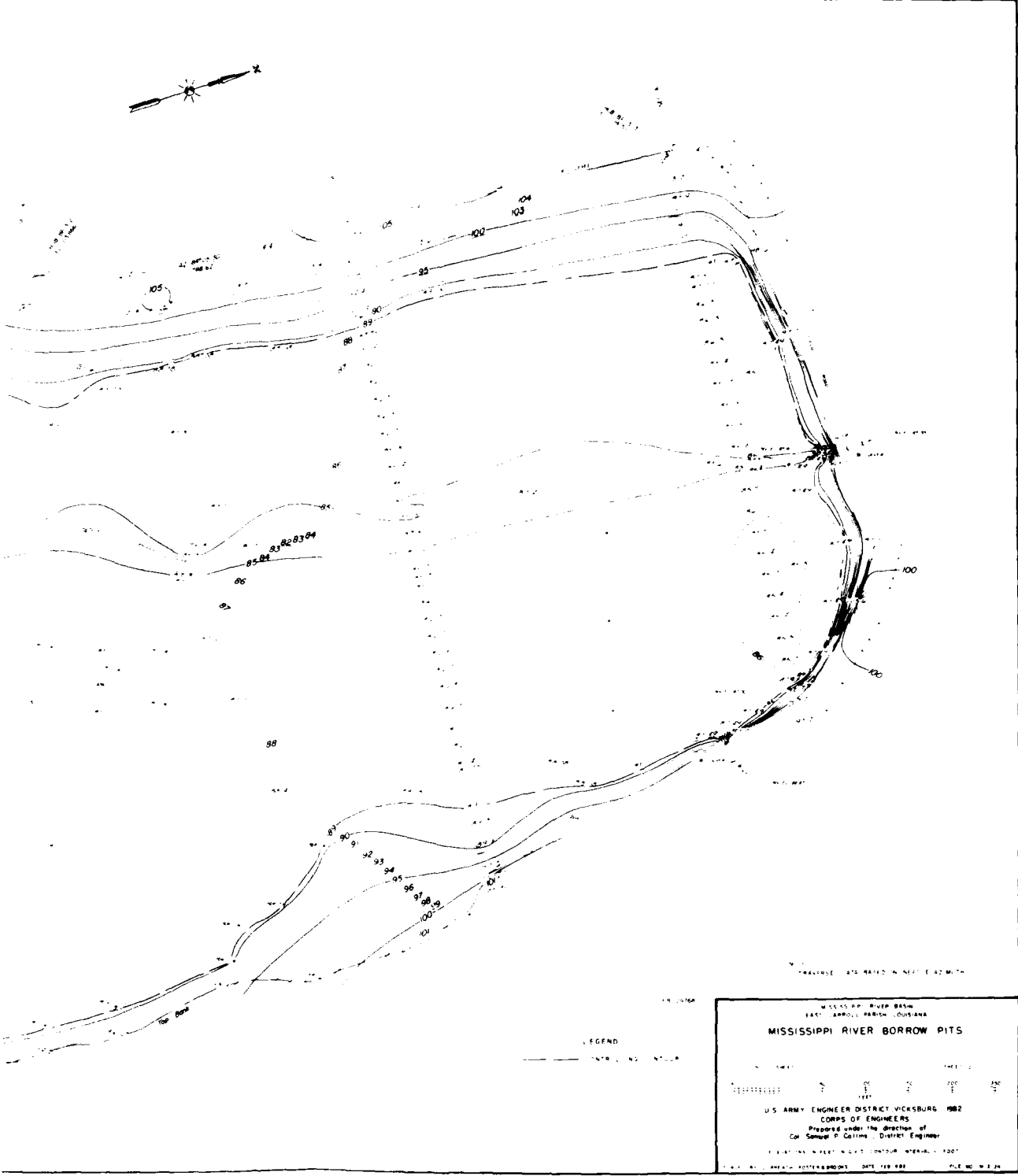
MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT VICKSBURG 382
CORPS OF ENGINEERS
Prepared under the direction of
Col Samuel P Collins, District Engineer

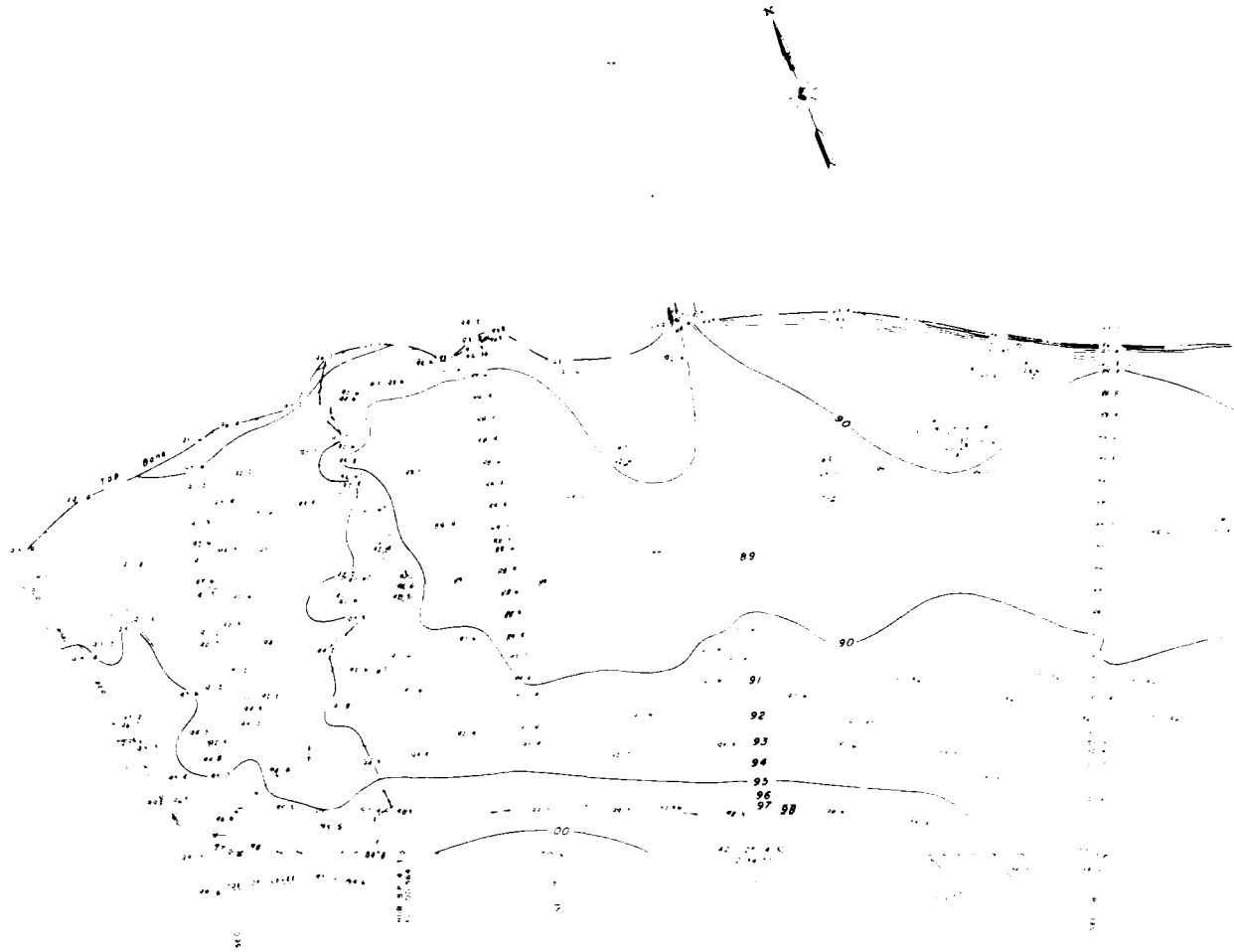
1. 作者：王 强 2. 单位：中国科学院植物研究所 3. 地址：北京 100871 4. 电话：010-64660000 5. 邮编：100871

CORPS OF ENGINEERS





CORPS OF ENGINEERS





NOTE
TRAVELER DATA BASED ON NEEDLE AT MOUTH

LEGEND
CONTINUOUS CONTOUR

MISSISSIPPI RIVER BASIN
EAST CARROLL PARK, LOUISIANA
MISSISSIPPI RIVER BORROW PITS

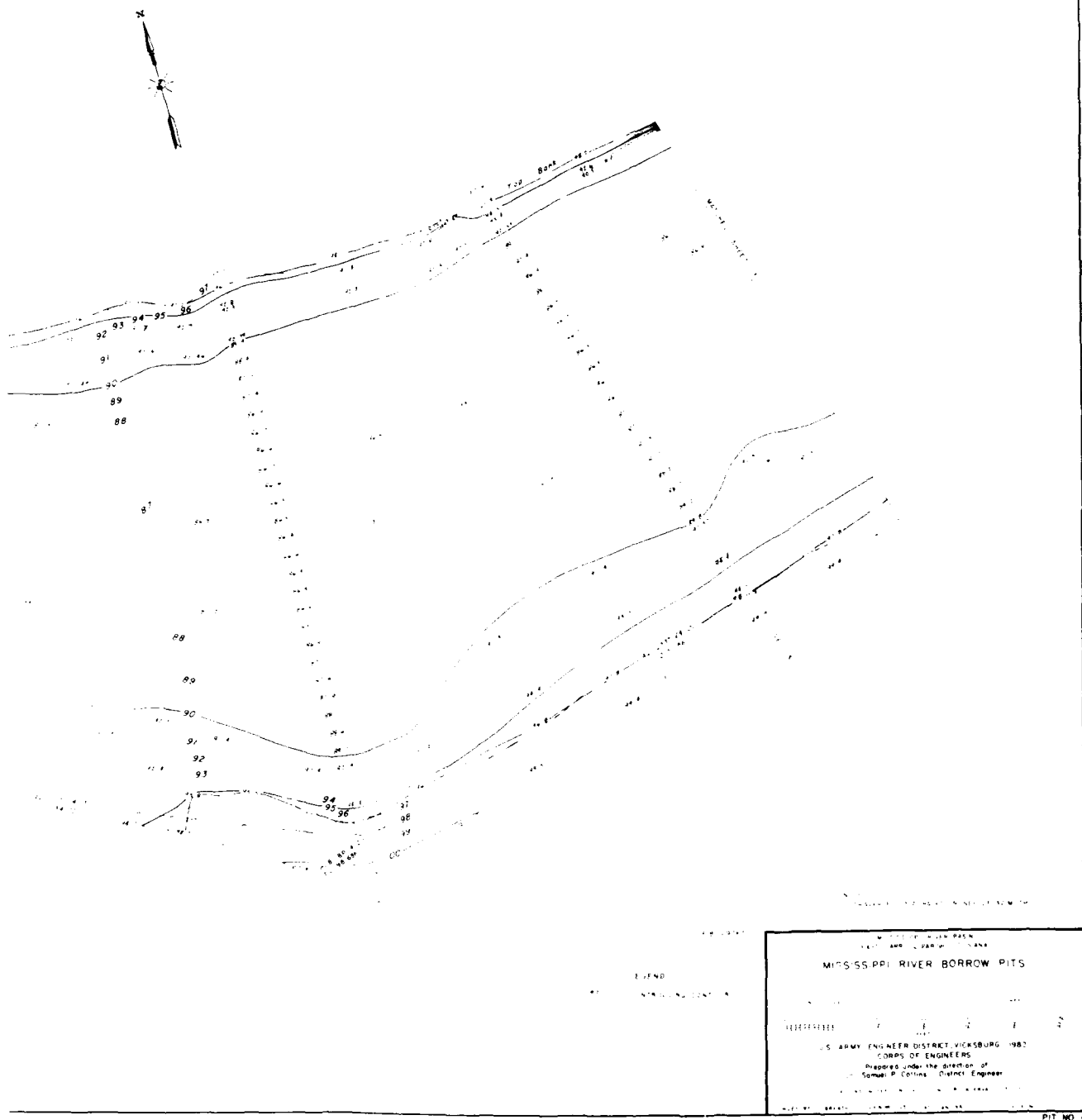
Scale: 1 inch = 1 mile

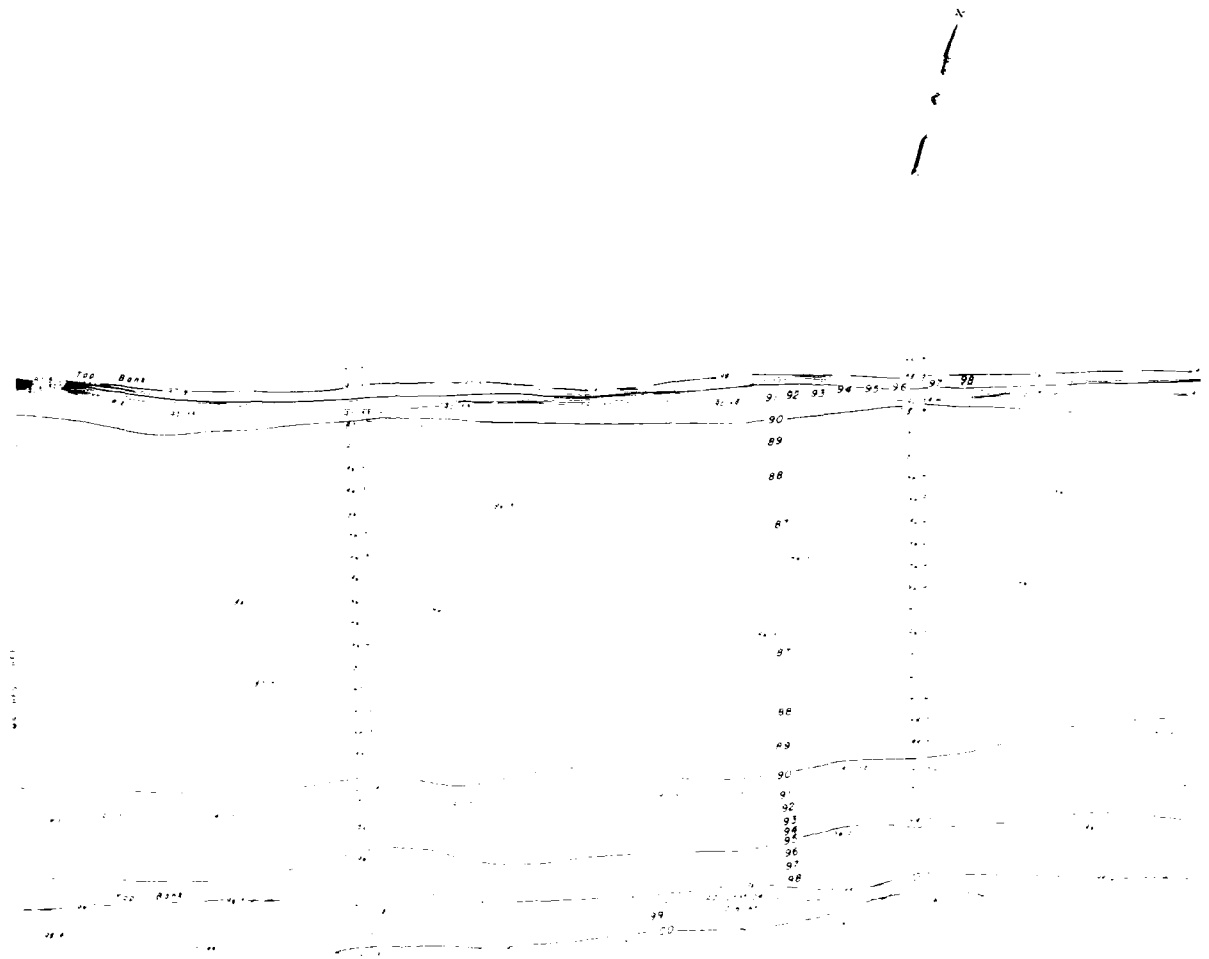
U.S. ARMY ENGINEER DISTRICT VICKSBURG 1982
CORPS OF ENGINEERS
Prepared under the direction of
Col. Samuel P. Collins, District Engineer

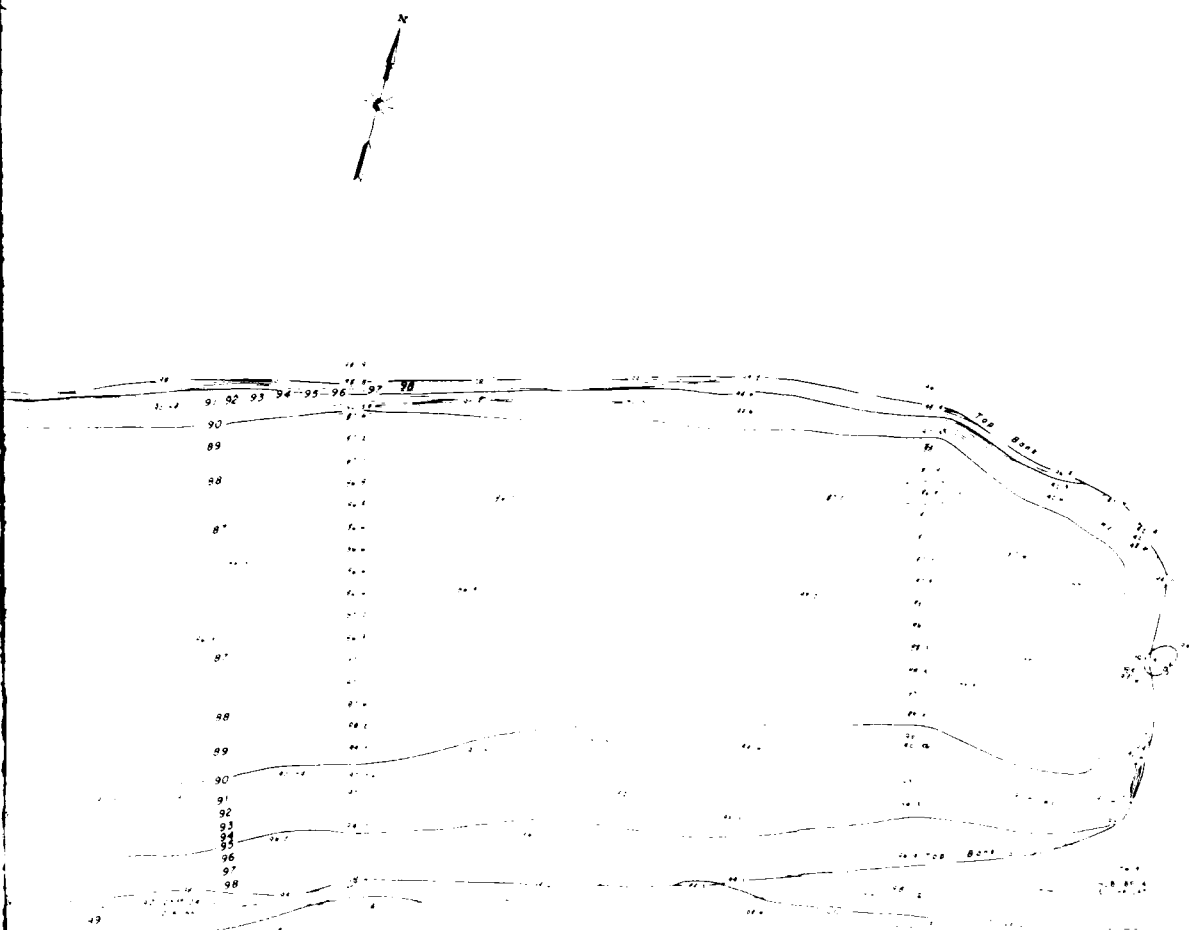
DATE: 10/1/82

2









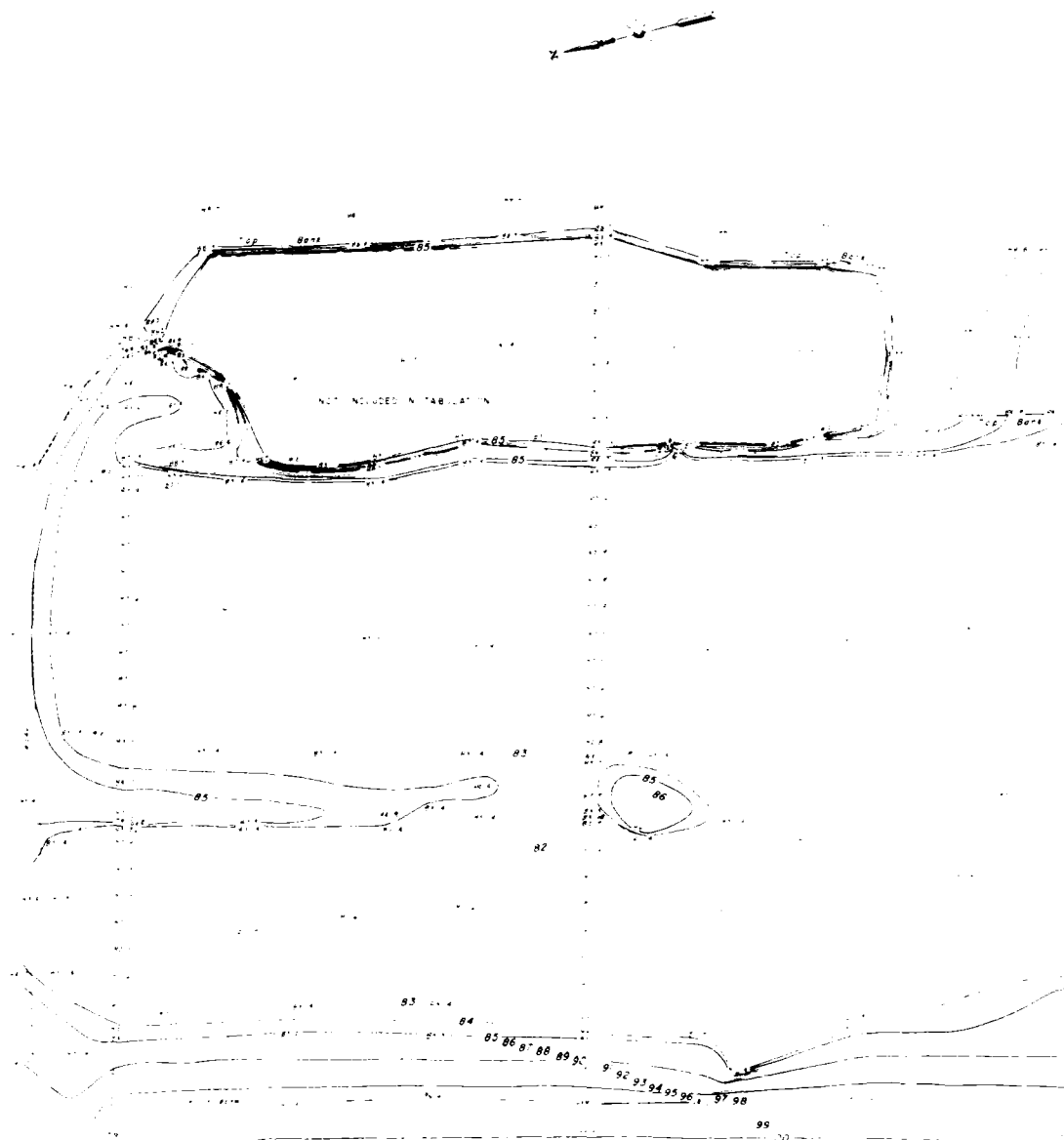
MISSISSIPPI RIVER BORROW PITS

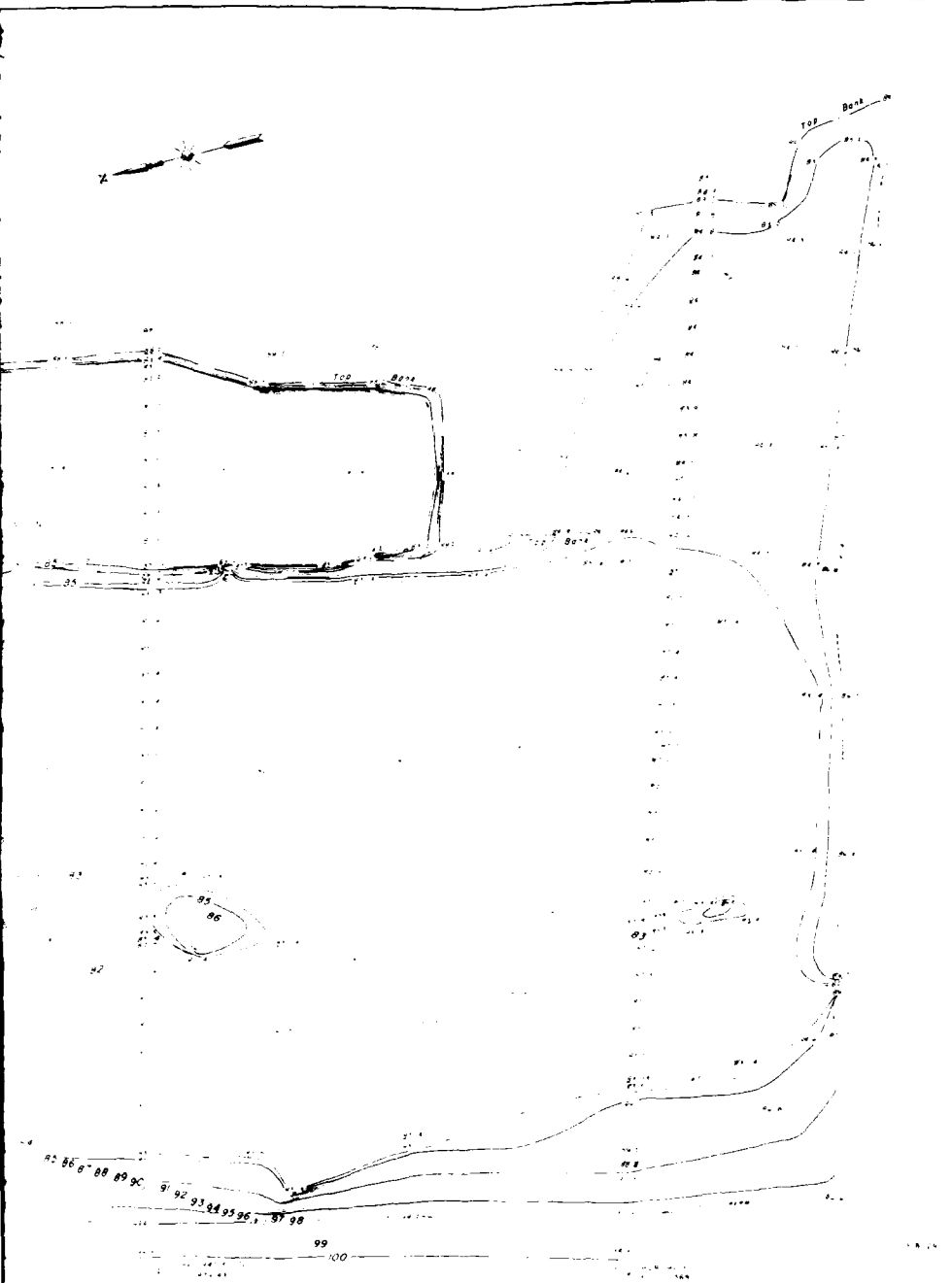
ENGINEERS

REPRODUCED FROM THE 1962 EDITION OF THE MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEERS

1-1



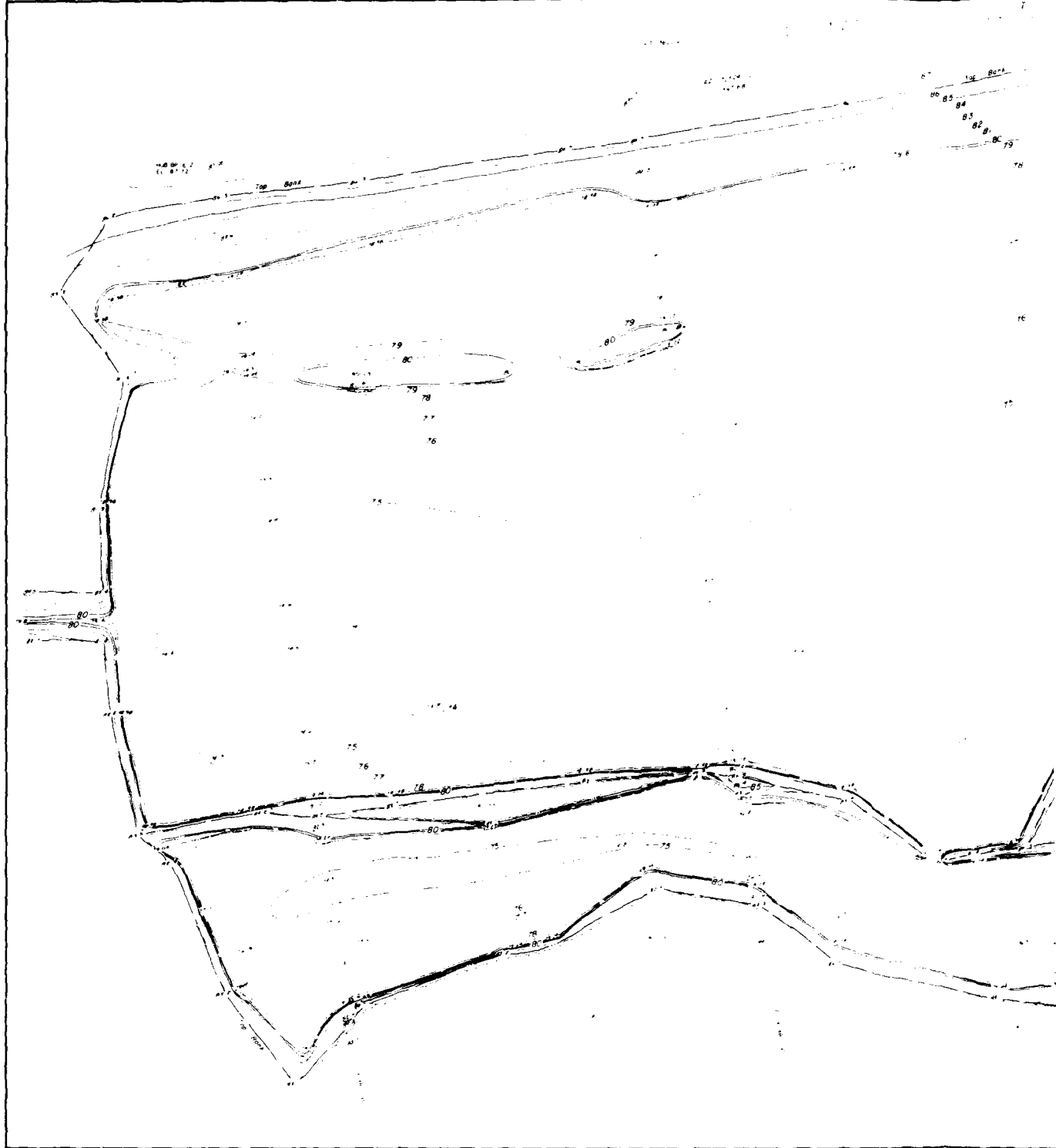


NOTE: TRAVERSE DATA BASED ON N.E. 1/4 40 M.W.

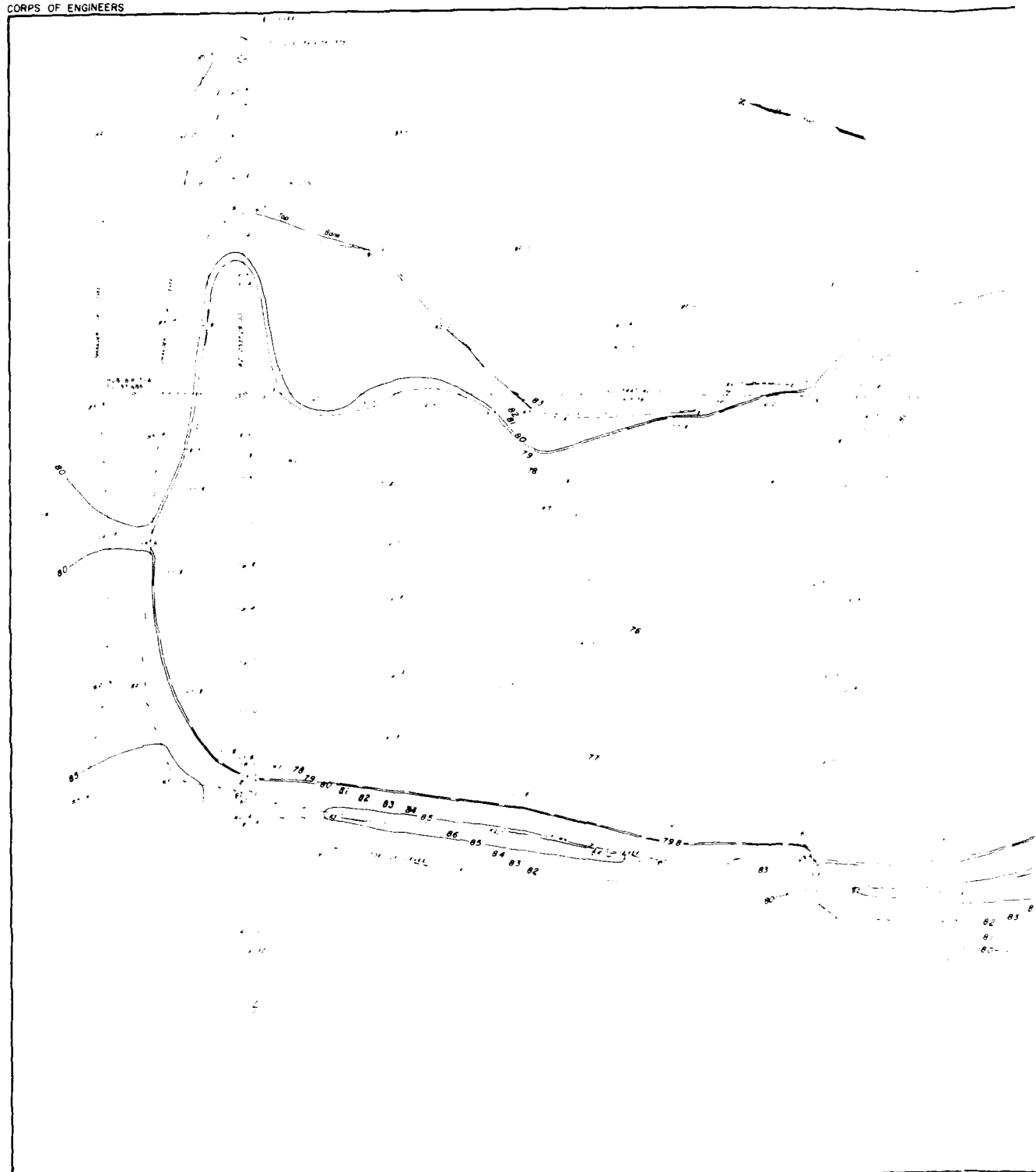
MISSISSIPPI RIVER BORROW PITS

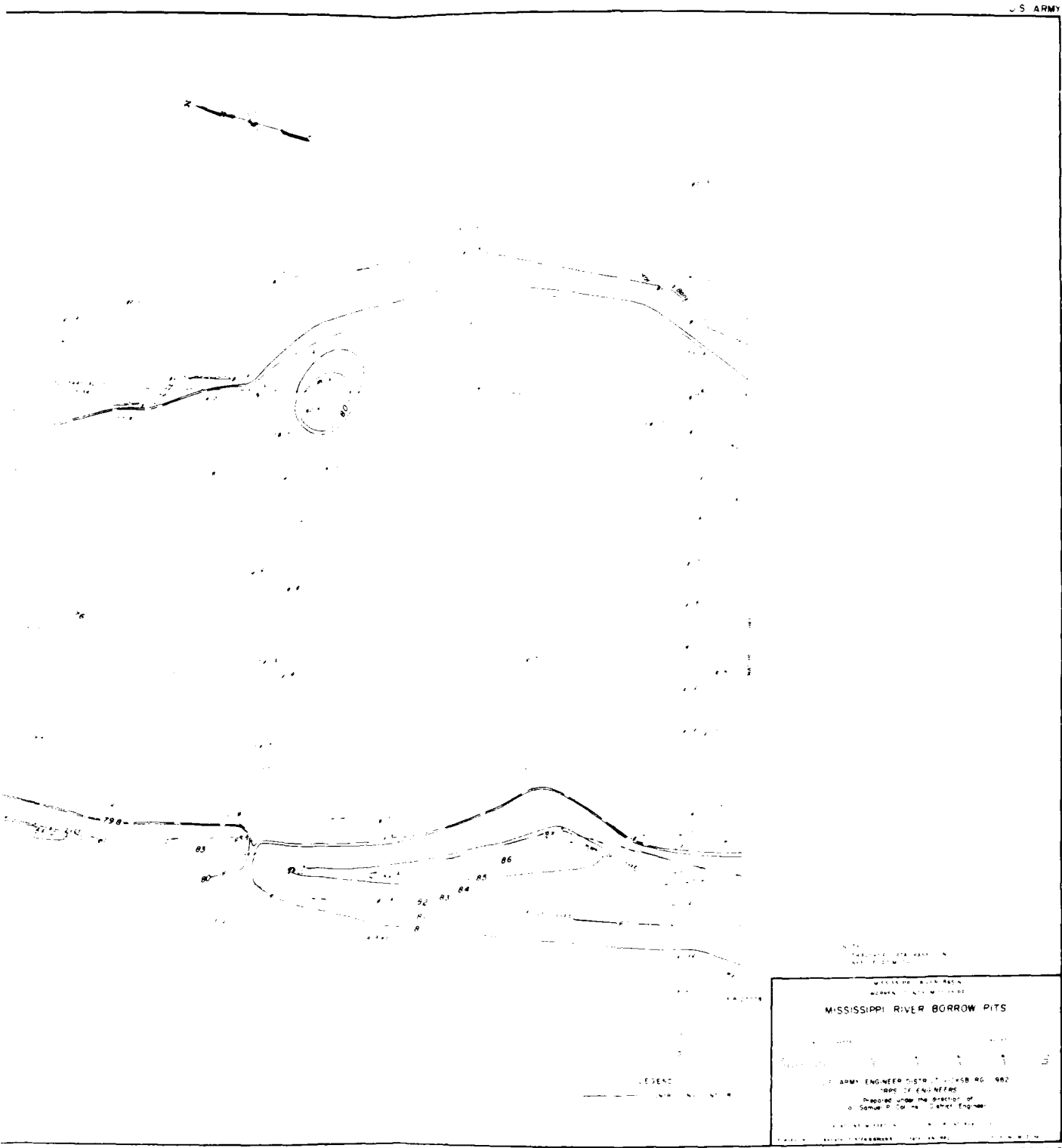
ENGINEER DISTRICT VICKSBURG 982
 Corps of Engineers
 Prepared under the direction of
 Col. Samuel P. Collins, District Engineer

CORPS OF ENGINEERS



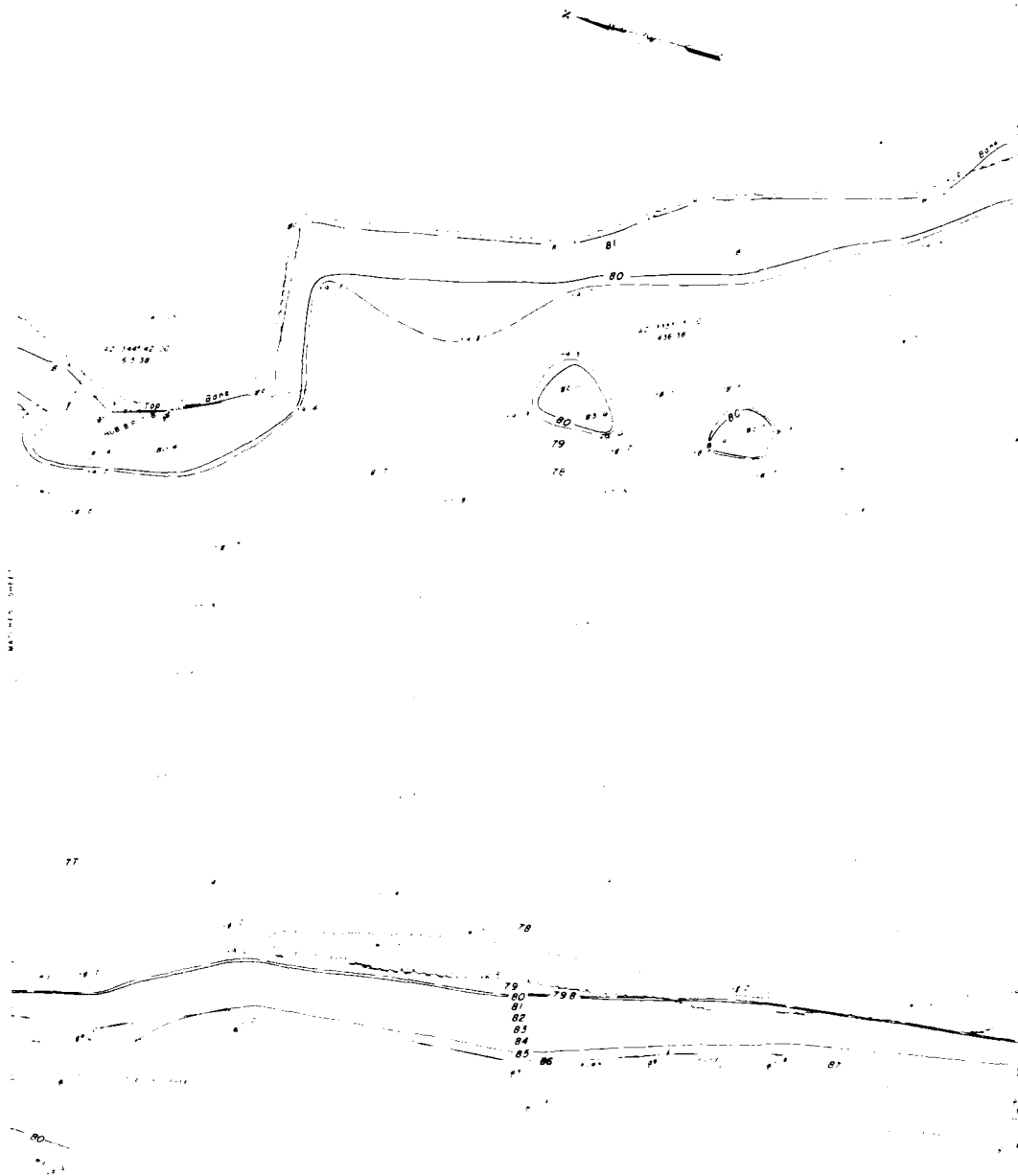
CORPS OF ENGINEERS

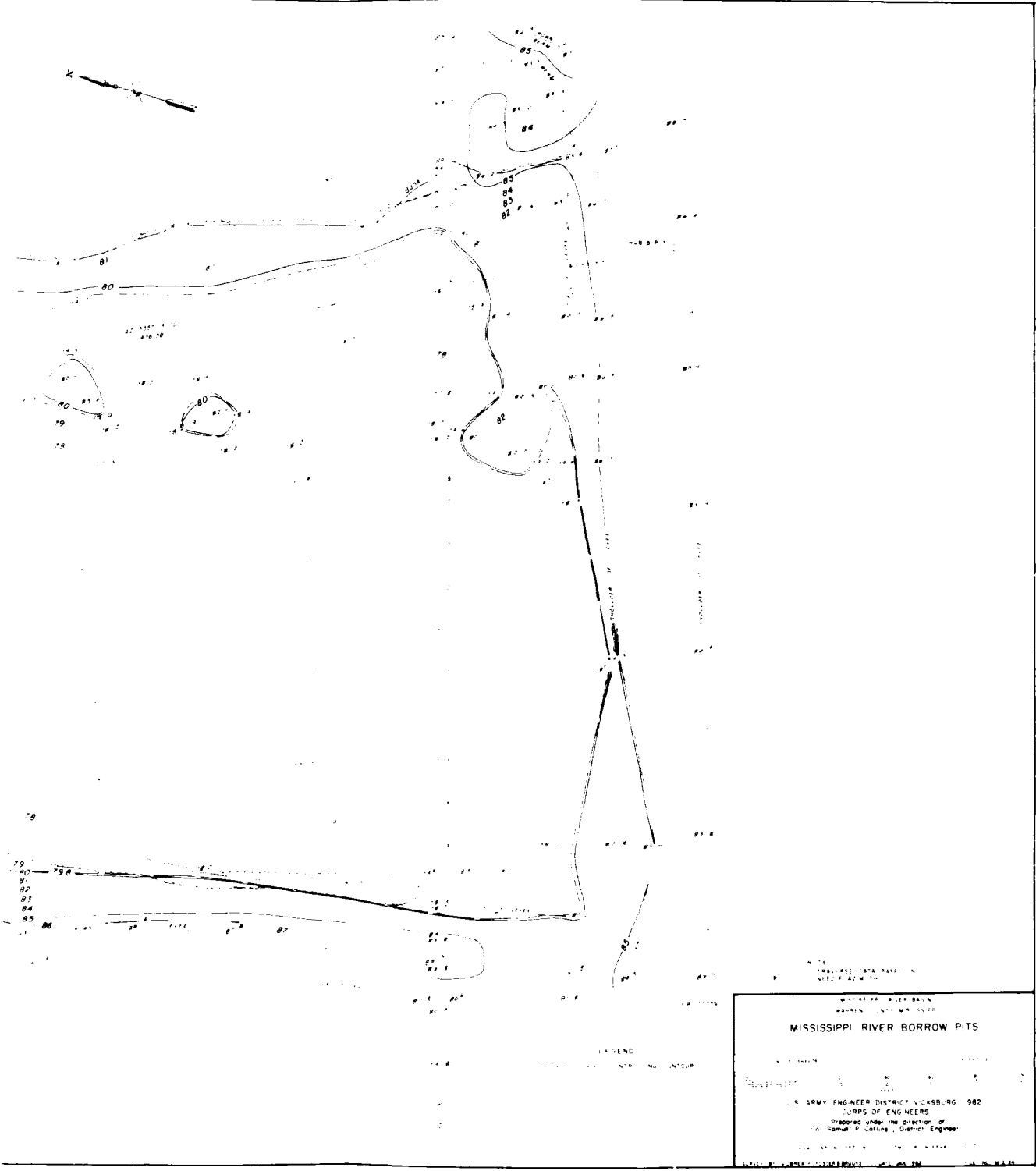


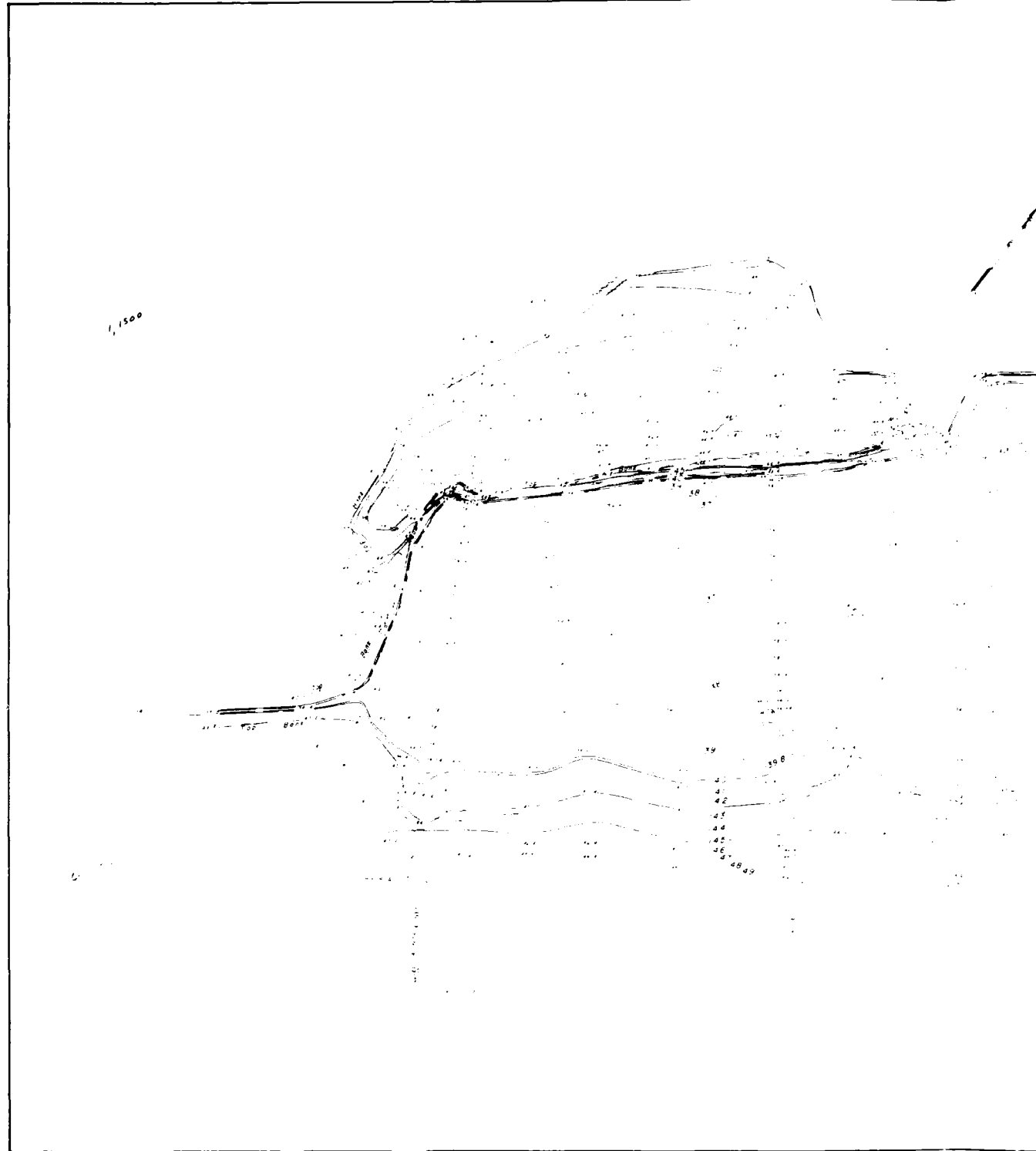


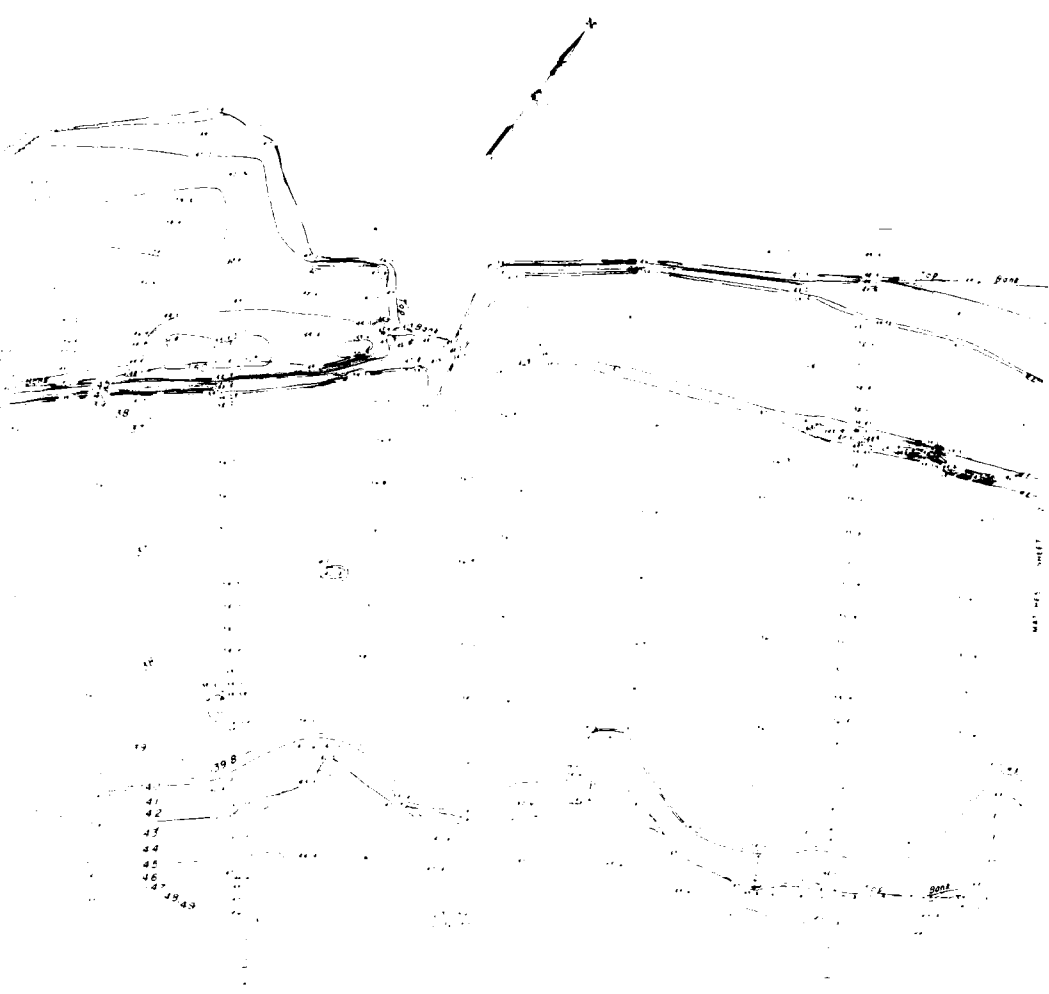
MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT NO. 1002
 DISTRICT OF ENGINEERS
 Prepared under the direction of
 O. Samuel P. Collins, District Engineer









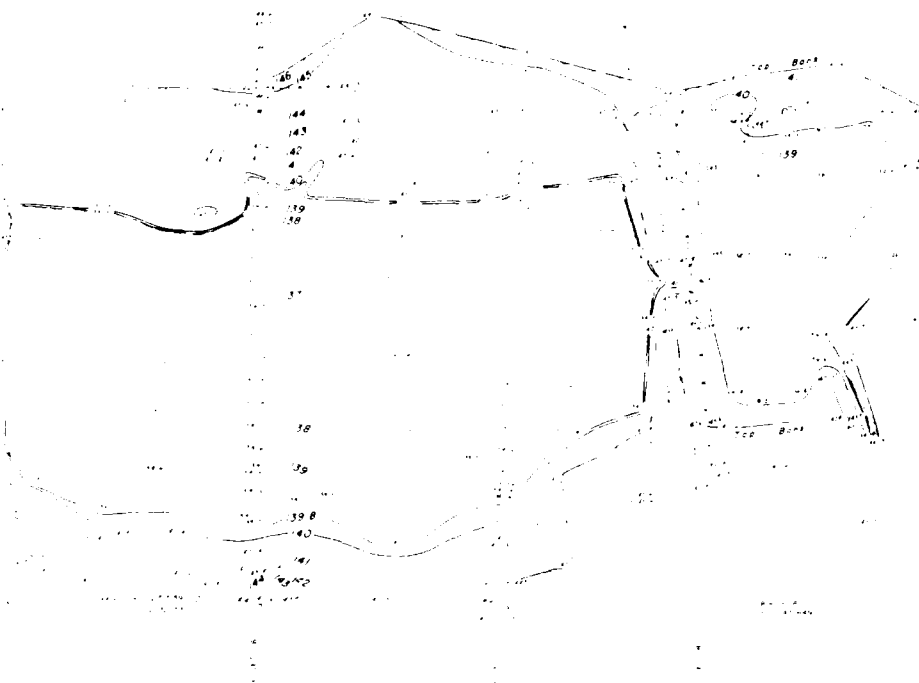
MISSISSIPPI RIVER BORROW PITS

JOHN W. KEEFER, DISTRICT ENGINEER
RCS DISTRICT ENGINEERS
Prepared Under the direction of
District Engineer

NC 8

CORPS OF ENGINEERS



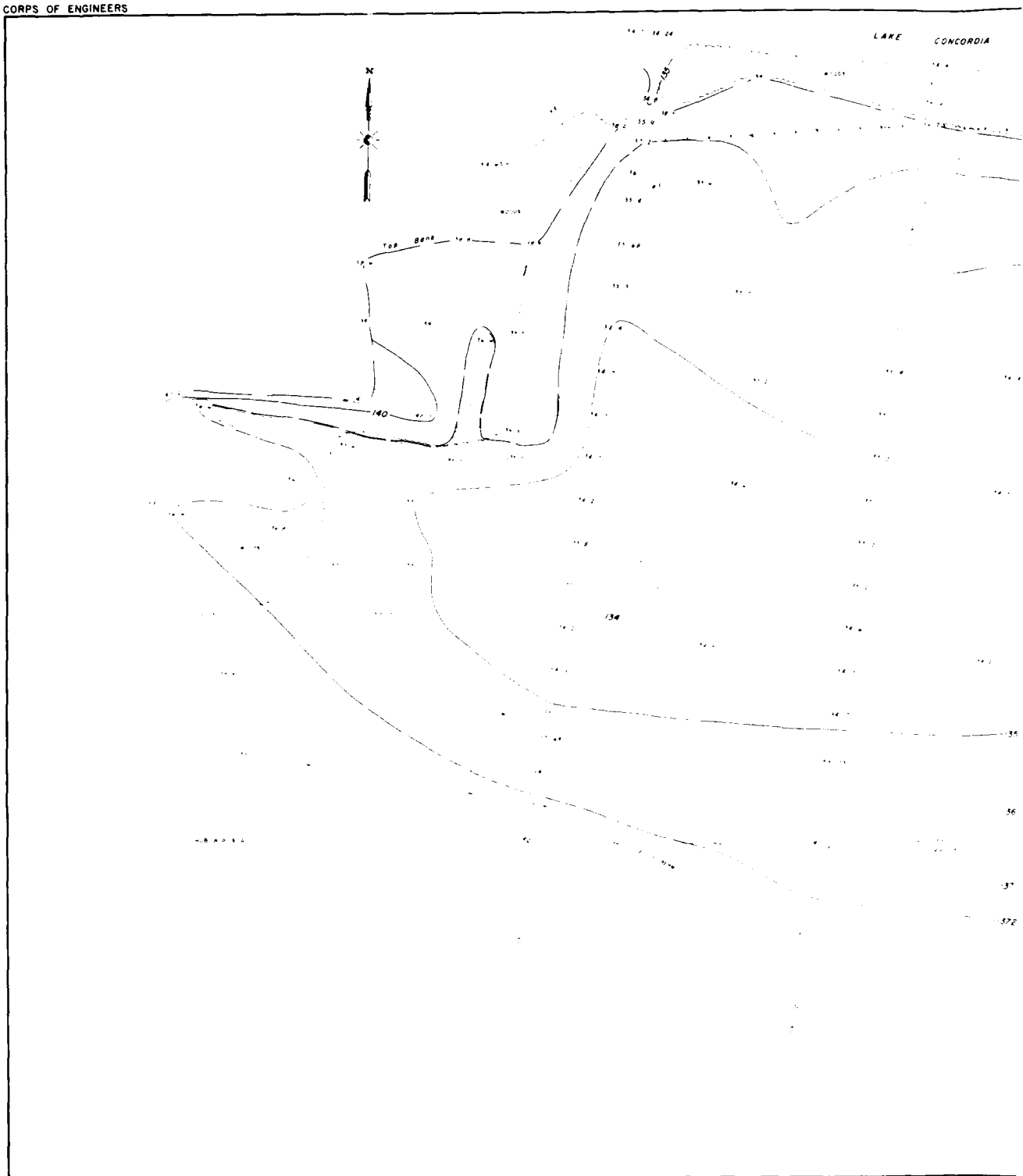
[illegible]

MISSISSIPPI RIVER BORROW PTS

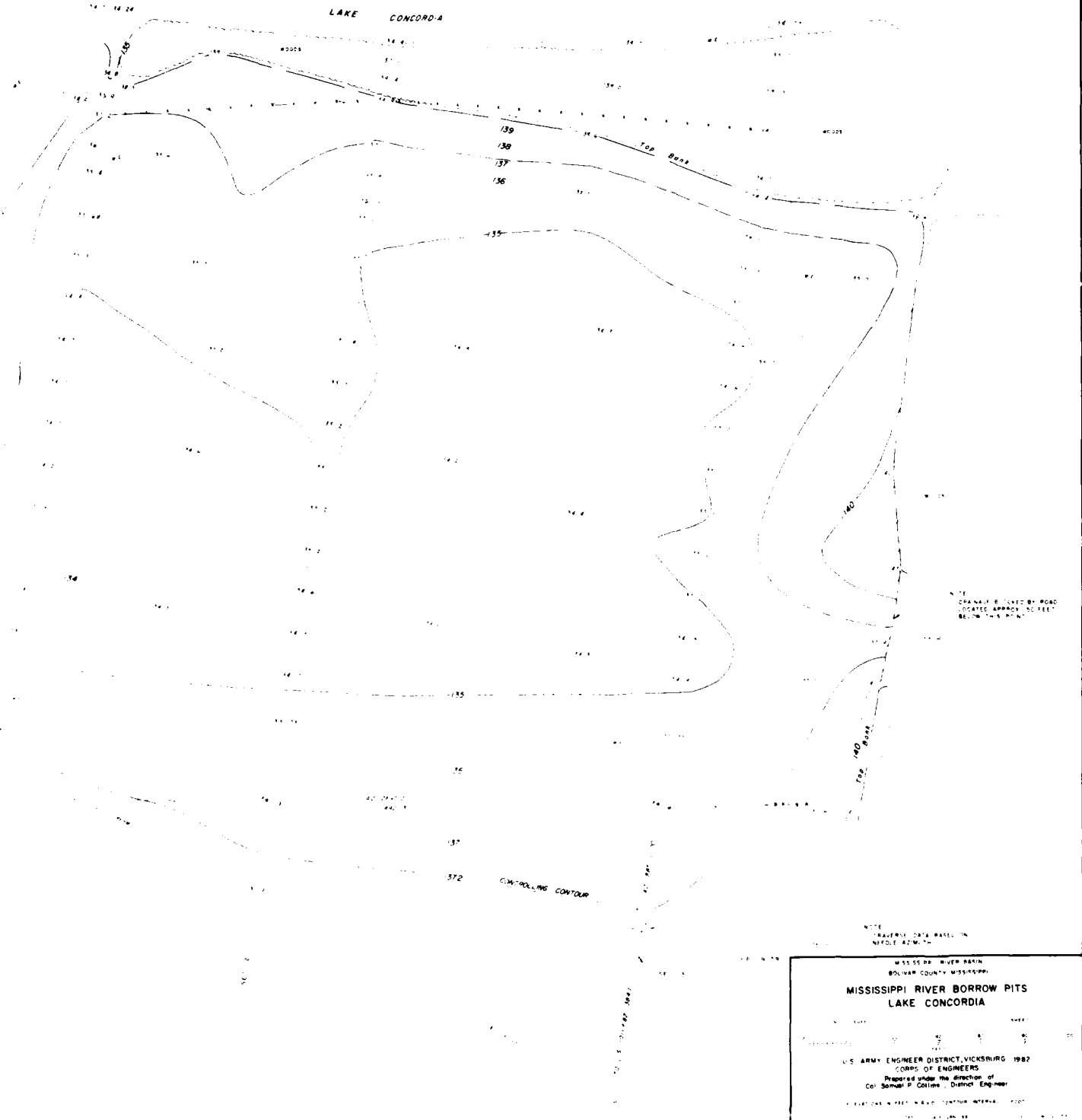
APPROXIMATELY ONE HUNDRED THOUSAND
 IN THE
 PREPARED UNDER THE DIRECTOR'S
 NAME OF THE UNITED STATES

6 40 2

CORPS OF ENGINEERS



LAKE CONCORDIA



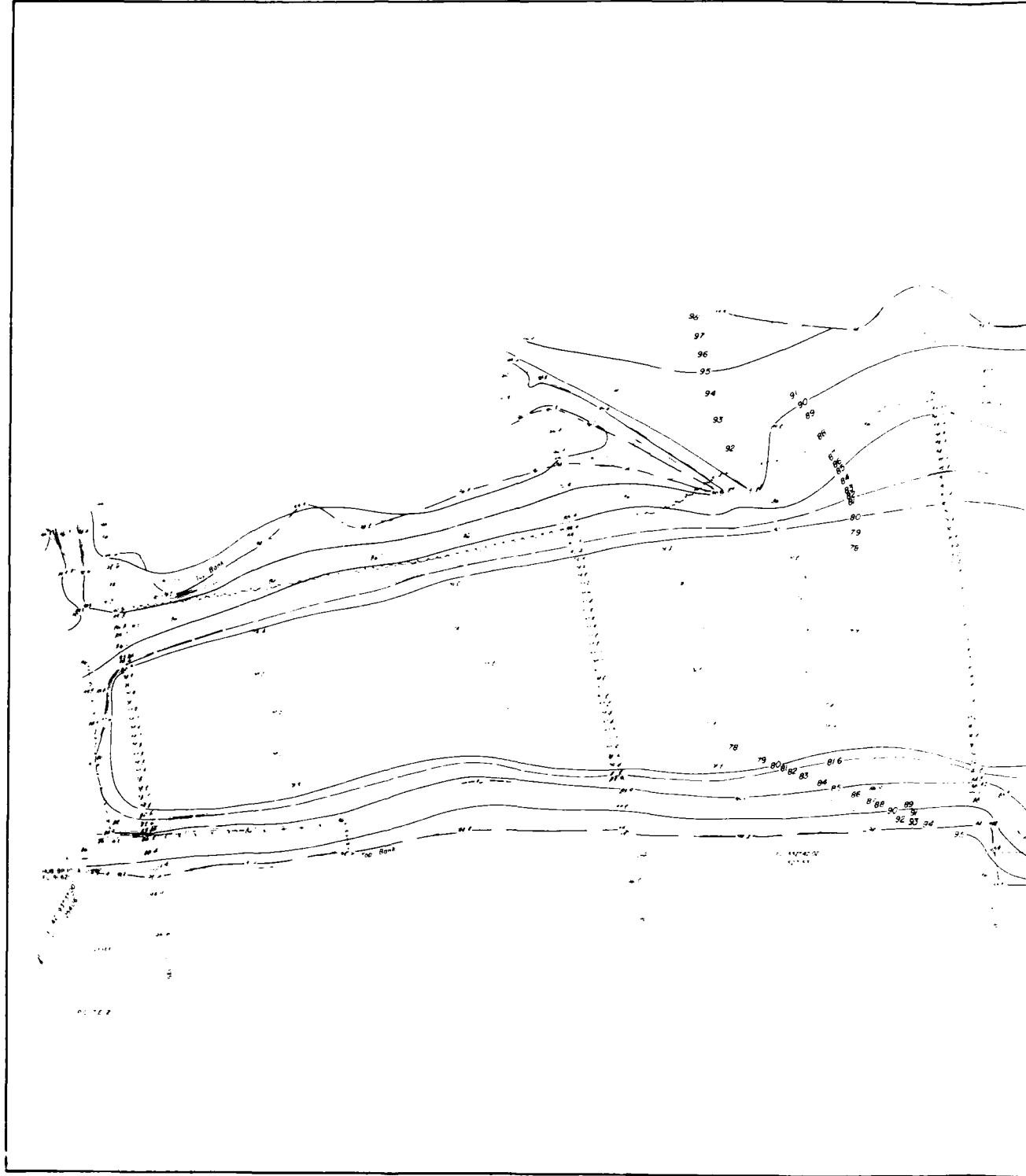
NOTE
CHANNEL LOCATED BY ROAD
LOCATED APPROX 50 FEET
BELOW THIS PIT

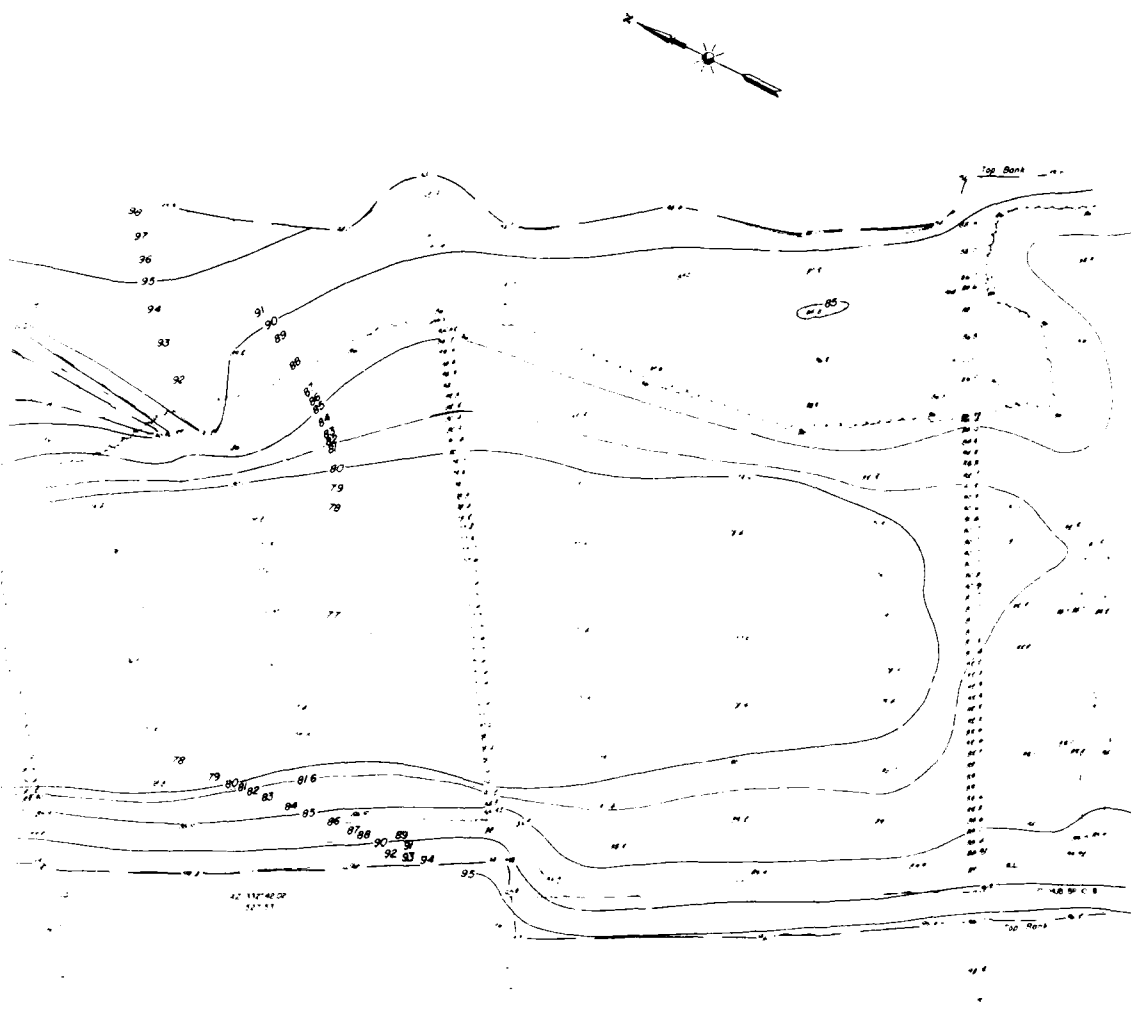
NOTE
TRAVERSE DATA BASED ON
NEEDLE AZIMUTH

MISSISSIPPI RIVER BORROW PITS
LAKE CONCORDIA

U.S. ARMY ENGINEER DISTRICT, VICKSBURG 1982
CORPS OF ENGINEERS
Prepared under the direction of
Col. Samuel P. Collins, District Engineer

CORPS OF ENGINEERS





LEGEND

MISSISSIPPI RIVER BORROW PIT

U.S. ARMY ENGINEER DISTRICT, VICKSBURG 1962

CORPS OF ENGINEERS

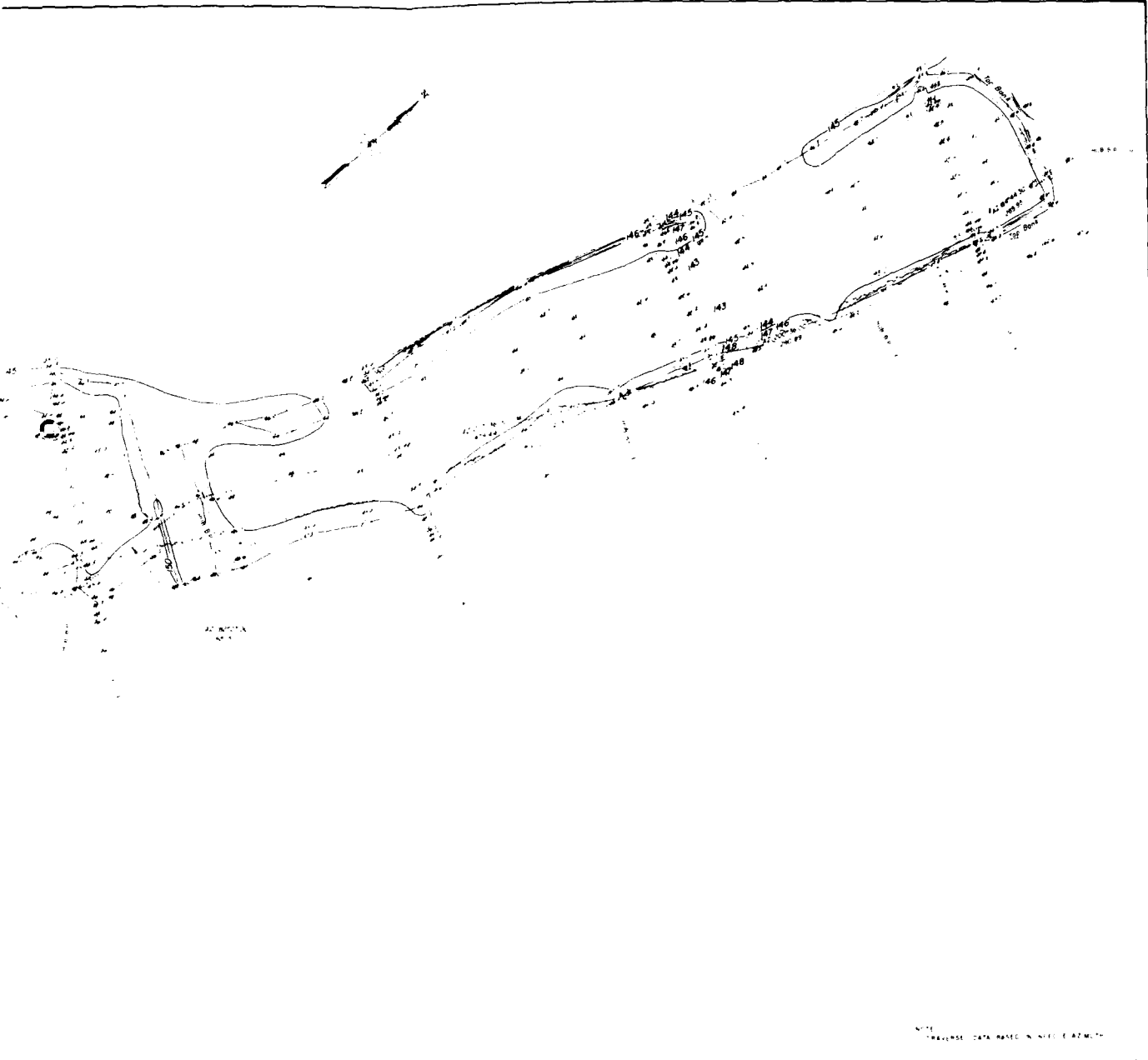
Prepared under the direction of

Col Samuel P. Collins, District Engineer

1:50,000 (1:50,000) (1:50,000) (1:50,000)

DATE: 10/1/62

PIT NO 10



NOTE
TRAVELER DATA BASED ON N 100 E AZIMUTH

CRITICAL

LEGEND

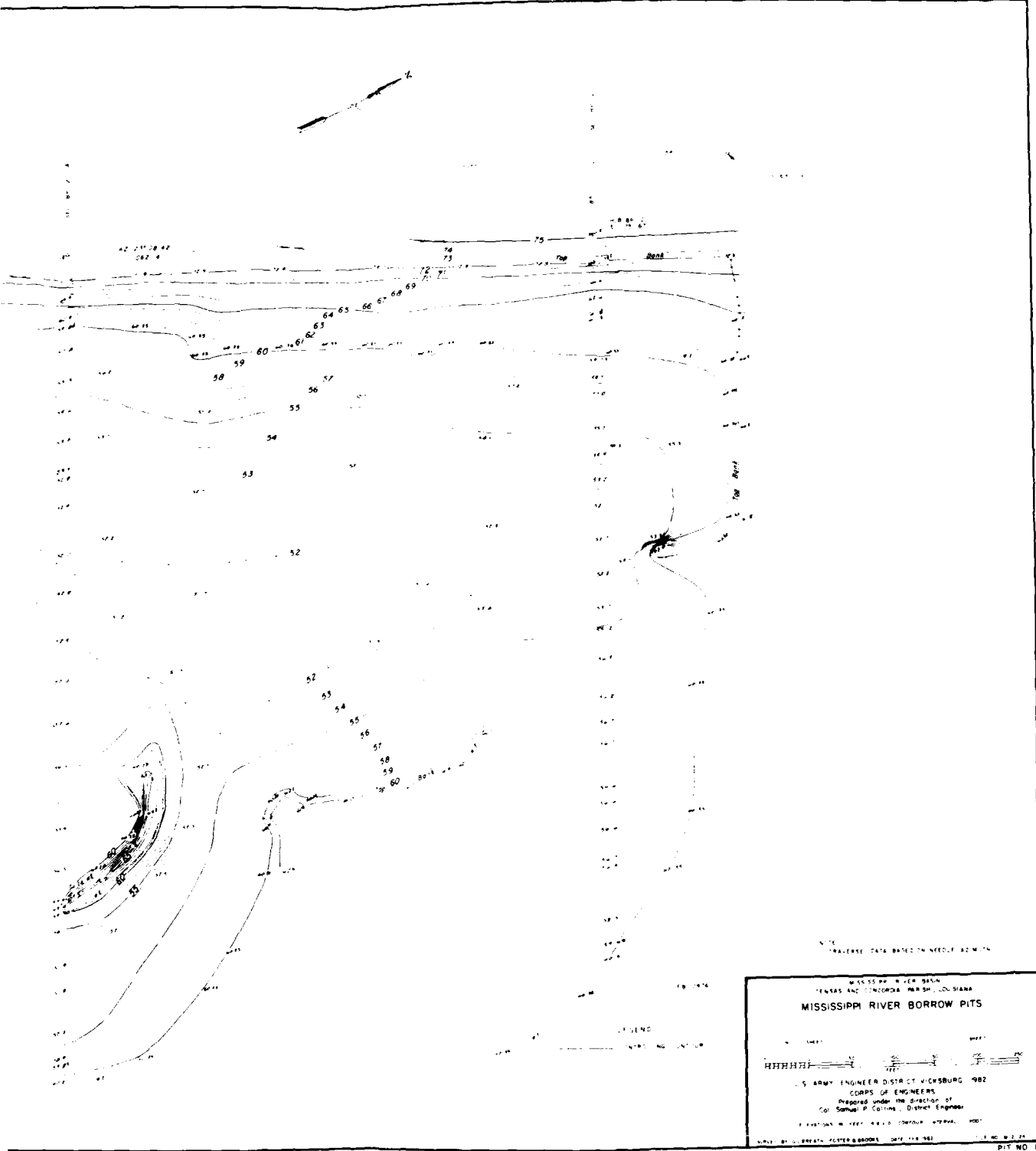
••• CONTROLLING CENTER

MISSISSIPPI RIVER BASIN
AT JARVIS COUNTY MISSISSIPPI
MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT VICKSBURG 1982
CORPS OF ENGINEERS
Prepared under the direction of
Col Samuel P. Collins, District Engineer

U.S. ARMY ENGINEER DISTRICT VICKSBURG 1982

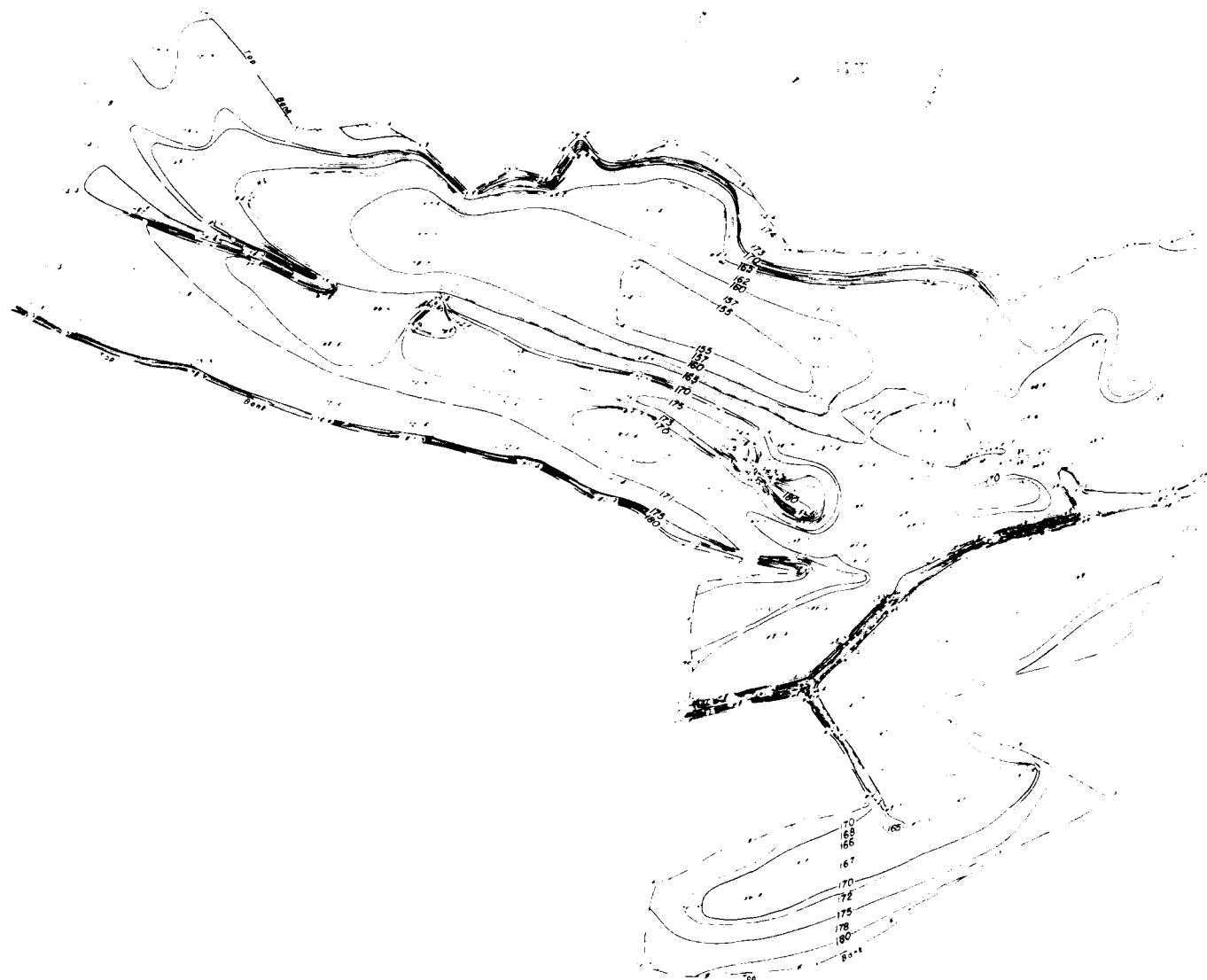
PIT NO 11



MISSISSIPPI RIVER BORROW PITS
TEXAS AND CONCORDIA PARISH, LOUISIANA

U.S. ARMY ENGINEER DISTRICT VICKSBURG 982
CORPS OF ENGINEERS
Prepared under the direction of
Col. Samuel P. Collins, District Engineer
ELEVATION IN FEET, 100' INTERVAL, 100'

CORPS OF ENGINEERS



)

1

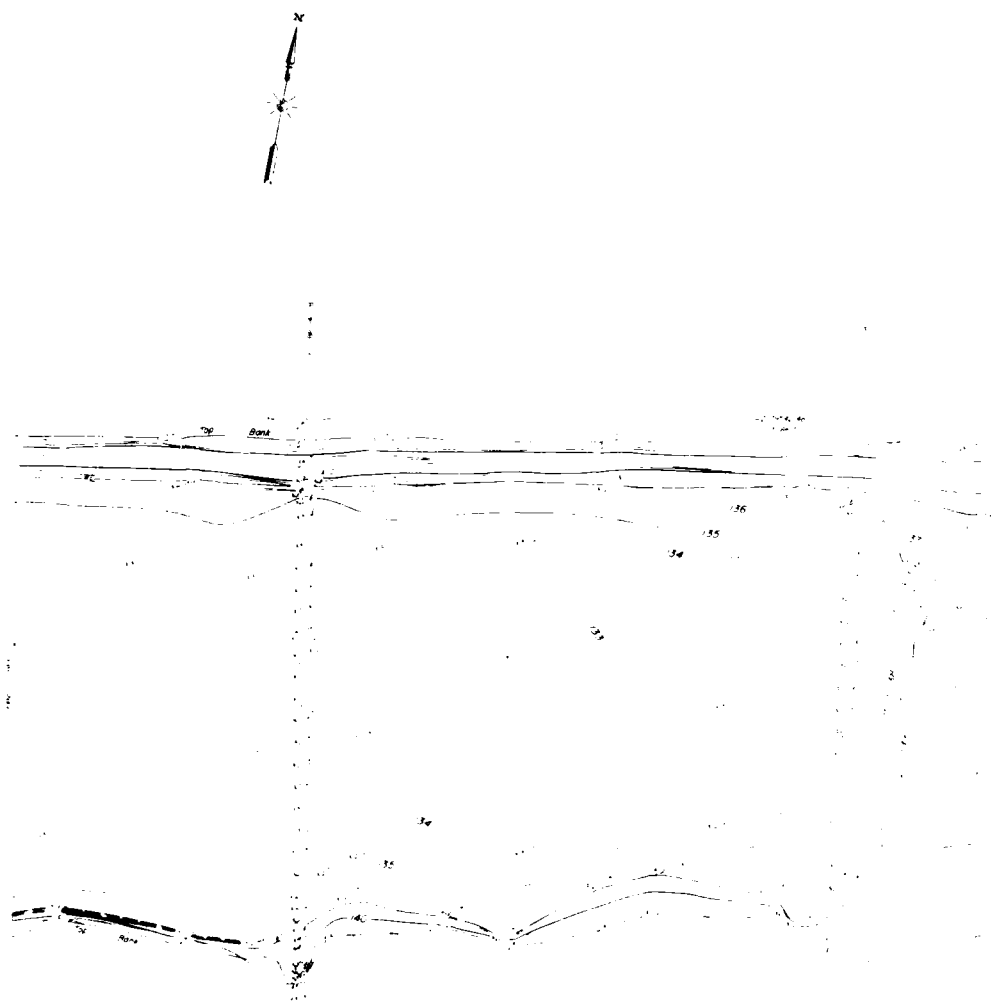


CORPS OF ENGINEERS



P: T NG

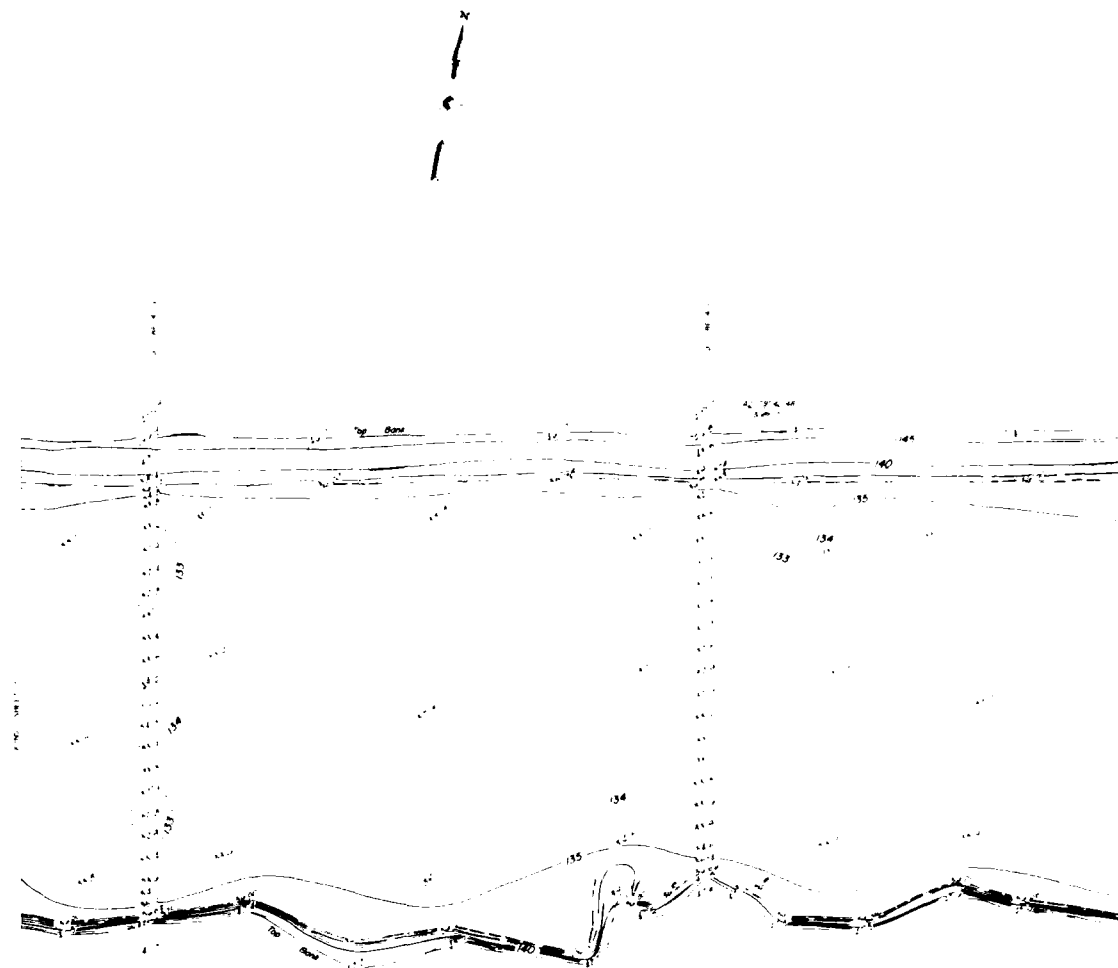
CORPS OF ENGINEERS

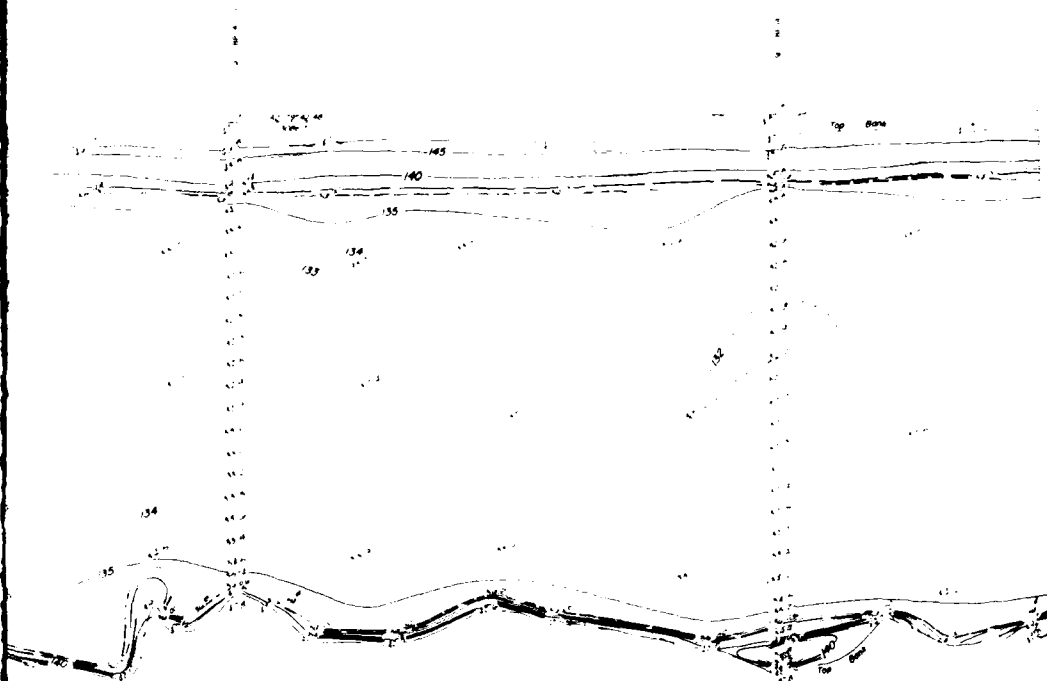




MISSISSIPPI RIVER BORROW PITS
 U.S. ARMY ENGINEER DISTRICT Vicksburg, MS 392
 DESIGNED UNDER THE DIRECTION OF
 THE DISTRICT ENGINEER, DISTRICT OF ENGINEERS
 U.S. ARMY ENGINEER DISTRICT Vicksburg, MS 392
 DESIGNED UNDER THE DIRECTION OF
 THE DISTRICT ENGINEER, DISTRICT OF ENGINEERS

CORPS OF ENGINEERS





NOTE
ELEVATION DATA BASED ON MEET 42 MOUTH

18 19022

LEGEND

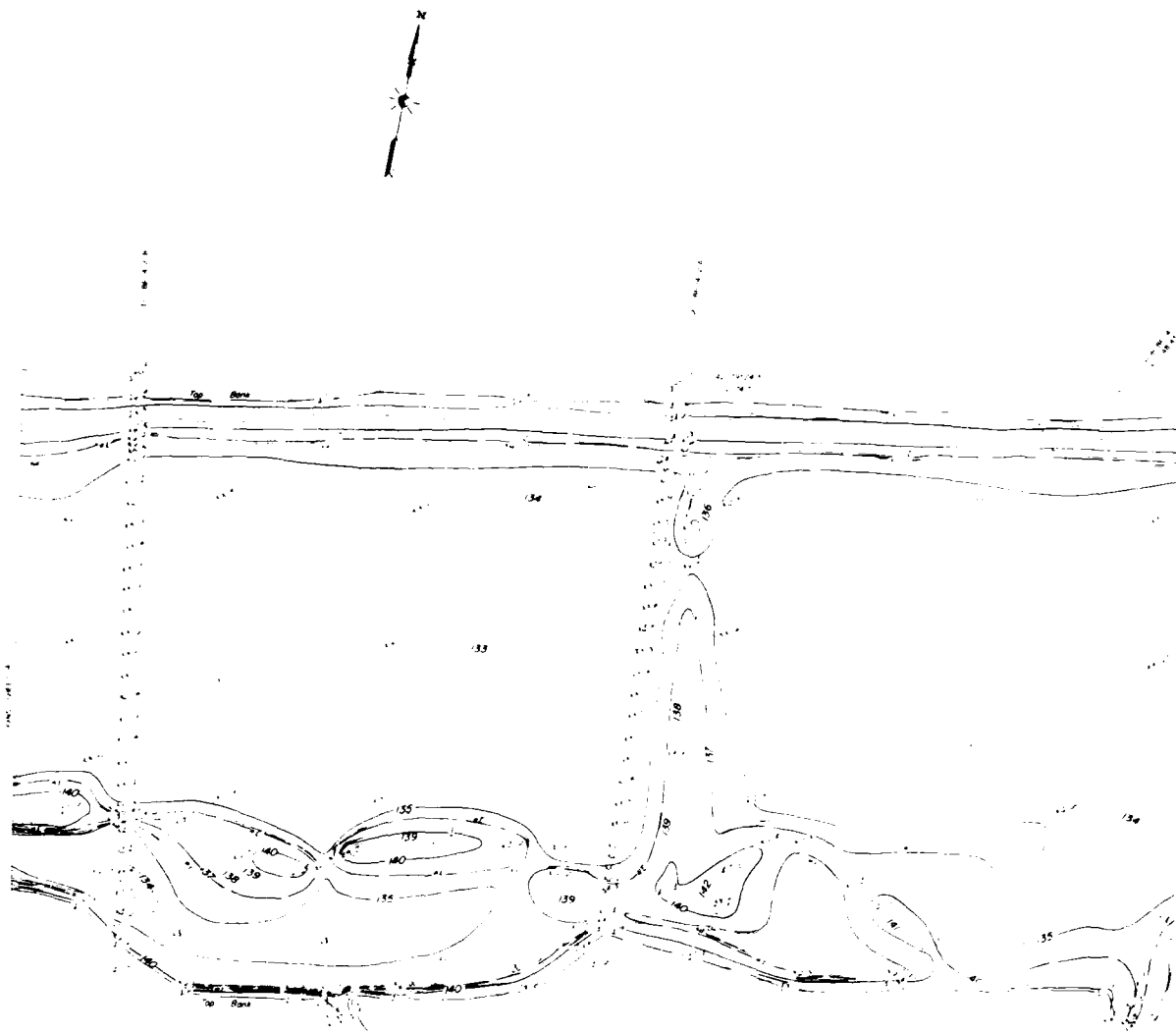
CONTROLLING ELEVATION

MISSISSIPPI RIVER BORROW PITS
DESHA COUNTY, ARKANSAS

U.S. ARMY ENGINEER DISTRICT, VICKSBURG 1982
CORPS OF ENGINEERS
Prepared under the direction of
Col. Samuel P. Collins, District Engineer
ELEVATIONS IN FEET & FEET CONTOUR INTERVAL 1000
SURVEY BY LANCEWORTH, JONES & BRIDGES, INC. FEB. 1982

PT NO 14

CORPS OF ENGINEERS



[illegible]

1992

MISSISSIPPI RED BASS
DECEMBER 10, 1964 ARKANSAS

MISSISSIPPI RIVER BORROW PITS

[illegible]

ARMY ENGINEER DISTRICT, VICKSBURG 3802
CORPS OF ENGINEERS

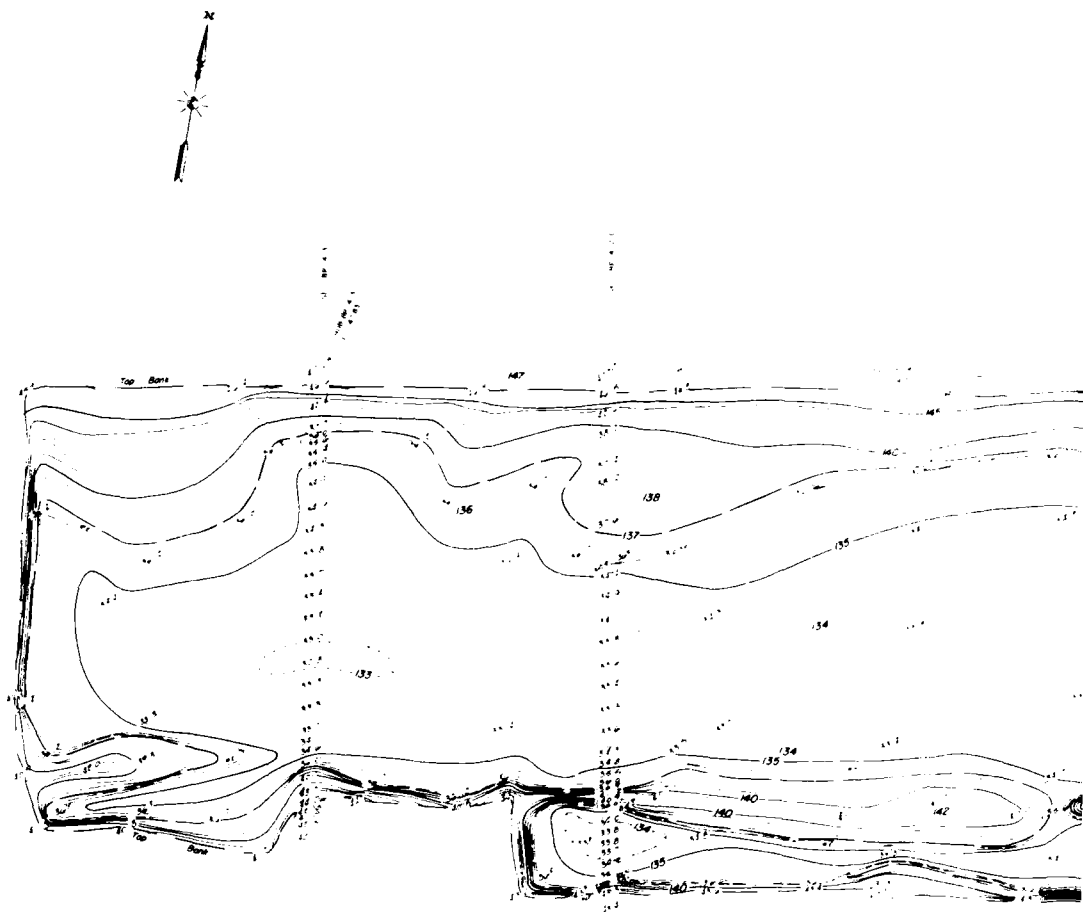
Prepared under the direction of
Samuel P. Collins, District Engineer

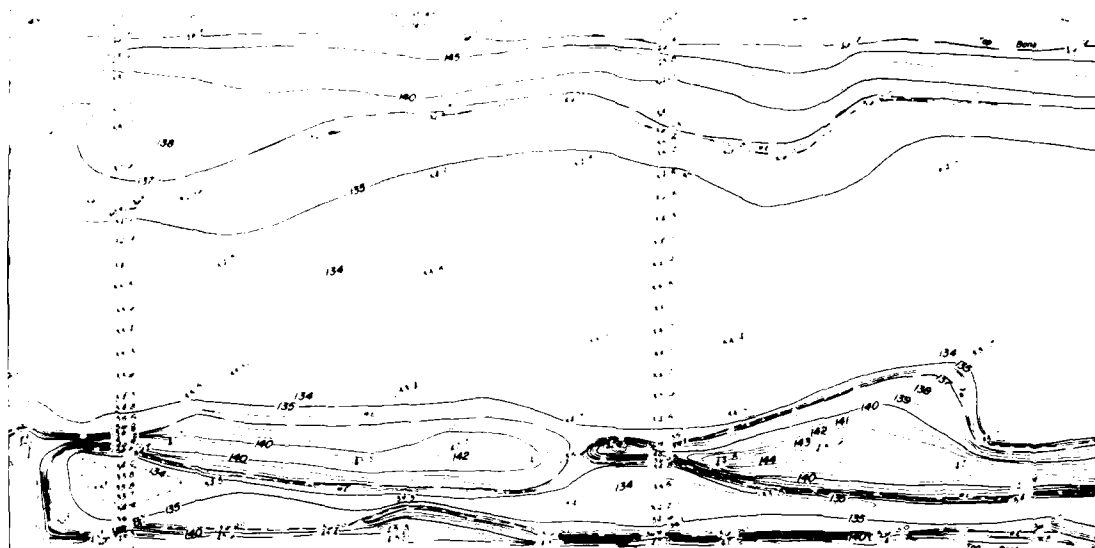
2000-2001-2002-2003-2004-2005-2006-2007-2008-2009-2010-2011-2012-2013-2014-2015-2016-2017-2018-2019-2020-2021-2022-2023-2024-2025-2026-2027-2028-2029-2030-2031-2032-2033-2034-2035-2036-2037-2038-2039-2040-2041-2042-2043-2044-2045-2046-2047-2048-2049-2050-2051-2052-2053-2054-2055-2056-2057-2058-2059-2060-2061-2062-2063-2064-2065-2066-2067-2068-2069-2070-2071-2072-2073-2074-2075-2076-2077-2078-2079-2080-2081-2082-2083-2084-2085-2086-2087-2088-2089-2090-2091-2092-2093-2094-2095-2096-2097-2098-2099-2100-2101-2102-2103-2104-2105-2106-2107-2108-2109-2110-2111-2112-2113-2114-2115-2116-2117-2118-2119-2120-2121-2122-2123-2124-2125-2126-2127-2128-2129-2130-2131-2132-2133-2134-2135-2136-2137-2138-2139-2140-2141-2142-2143-2144-2145-2146-2147-2148-2149-2150-2151-2152-2153-2154-2155-2156-2157-2158-2159-2160-2161-2162-2163-2164-2165-2166-2167-2168-2169-2170-2171-2172-2173-2174-2175-2176-2177-2178-2179-2180-2181-2182-2183-2184-2185-2186-2187-2188-2189-2190-2191-2192-2193-2194-2195-2196-2197-2198-2199-2200-2201-2202-2203-2204-2205-2206-2207-2208-2209-2210-2211-2212-2213-2214-2215-2216-2217-2218-2219-2220-2221-2222-2223-2224-2225-2226-2227-2228-2229-2230-2231-2232-2233-2234-2235-2236-2237-2238-2239-2240-2241-2242-2243-2244-2245-2246-2247-2248-2249-2250-2251-2252-2253-2254-2255-2256-2257-2258-2259-2260-2261-2262-2263-2264-2265-2266-2267-2268-2269-2270-2271-2272-2273-2274-2275-2276-2277-2278-2279-2280-2281-2282-2283-2284-2285-2286-2287-2288-2289-2290-2291-2292-2293-2294-2295-2296-2297-2298-2299-2300-2301-2302-2303-2304-2305-2306-2307-2308-2309-2310-2311-2312-2313-2314-2315-2316-2317-2318-2319-2320-2321-2322-2323-2324-2325-2326-2327-2328-2329-2330-2331-2332-2333-2334-2335-2336-2337-2338-2339-2340-2341-2342-2343-2344-2345-2346-2347-2348-2349-2350-2351-2352-2353-2354-2355-2356-2357-2358-2359-2360-2361-2362-2363-2364-2365-2366-2367-2368-2369-2370-2371-2372-2373-2374-2375-2376-2377-2378-2379-2380-2381-2382-2383-2384-2385-2386-2387-2388-2389-2390-2391-2392-2393-2394-2395-2396-2397-2398-2399-2400-2401-2402-2403-2404-2405-2406-2407-2408-2409-2410-2411-2412-2413-2414-2415-2416-2417-2418-2419-2420-2421-2422-2423-2424-2425-2426-2427-2428-2429-2430-2431-2432-2433-2434-2435-2436-2437-2438-2439-2440-2441-2442-2443-2444-2445-2446-2447-2448-2449-2450-2451-2452-2453-2454-2455-2456-2457-2458-2459-2460-2461-2462-2463-2464-2465-2466-2467-2468-2469-2470-2471-2472-2473-2474-2475-2476-2477-2478-2479-2480-2481-2482-2483-2484-2485-2486-2487-2488-2489-2490-2491-2492-2493-2494-2495-2496-2497-2498-2499-2500-2501-2502-2503-2504-2505-2506-2507-2508-2509-2510-2511-2512-2513-2514-2515-2516-2517-2518-2519-2520-2521-2522-2523-2524-2525-2526-2527-2528-2529-2530-2531-2532-2533-2534-2535-2536-2537-2538-2539-2540-2541-2542-2543-2544-2545-2546-2547-2548-2549-2550-2551-2552-2553-2554-2555-2556-2557-2558-2559-2560-2561-2562-2563-2564-2565-2566-2567-2568-2569-2570-2571-2572-2573-2574-2575-2576-2577-2578-2579-2580-2581-2582-2583-2584-2585-2586-2587-2588-2589-2590-2591-2592-2593-2594-2595-2596-2597-2598-2599-2600-2601-2602-2603-2604-2605-2606-2607-2608-2609-2610-2611-2612-2613-2614-2615-2616-2617-2618-2619-2620-2621-2622-2623-2624-2625-2626-2627-2628-2629-2630-2631-2632-2633-2634-2635-2636-2637-2638-2639-2640-2641-2642-2643-2644-2645-2646-2647-2648-2649-2650-2651-2652-2653-2654-2655-2656-2657-2658-2659-2660-2661-2662-2663-2664-2665-2666-2667-2668-2669-2670-2671-2672-2673-2674-2675-2676-2677-2678-2679-2680-2681-2682-2683-2684-2685-2686-2687-2688-2689-2690-2691-2692-2693-2694-2695-2696-2697-2698-2699-2700-2701-2702-2703-2704-2705-2706-2707-2708-2709-2710-2711-2712-2713-2714-2715-2716-2717-2718-2719-2720-2721-2722-2723-2724-2725-2726-2727-2728-2729-2730-2731-2732-2733-2734-2735-2736-2737-2738-2739-2740-2741-2742-2743-2744-2745-2746-2747-2748-2749-2750-2751-2752-2753-2754-2755-2756-2757-2758-2759-2760-2761-2762-2763-2764-2765-2766-2767-2768-2769-2770-2771-2772-2773-2774-2775-2776-2777-2778-2779-2780-2781-2782-2783-2784-2785-2786-2787-2788-2789-2790-2791-2792-2793-2794-2795-2796-2797-2798-2799-2800-2801-2802-2803-2804-2805-2806-2807-2808-2809-2810-2811-2812-2813-2814-2815-2816-2817-2818

U.S. DEPT. OF JUSTICE OFFICE OF THE ATTORNEY GENERAL

ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED DATE 07-08-93 BY SP-6 BTJ/KJS

PIT NO 14





WAVELENGTH DATA BASED ON NEEDLE AZIMUTH

• 6 29922

MISSISSIPPI OVER BOARD
DE SAA COUNTY ARKANSAS

MISSISSIPPI RIVER BORROW PITS

4-5-67

2000 10 10

90	95	GC	90	200	19
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9
10	10	10	10	10	10
11	11	11	11	11	11
12	12	12	12	12	12
13	13	13	13	13	13
14	14	14	14	14	14
15	15	15	15	15	15
16	16	16	16	16	16
17	17	17	17	17	17
18	18	18	18	18	18
19	19	19	19	19	19
20	20	20	20	20	20
21	21	21	21	21	21
22	22	22	22	22	22
23	23	23	23	23	23
24	24	24	24	24	24
25	25	25	25	25	25
26	26	26	26	26	26
27	27	27	27	27	27
28	28	28	28	28	28
29	29	29	29	29	29
30	30	30	30	30	30
31	31	31	31	31	31
32	32	32	32	32	32
33	33	33	33	33	33
34	34	34	34	34	34
35	35	35	35	35	35
36	36	36	36	36	36
37	37	37	37	37	37
38	38	38	38	38	38
39	39	39	39	39	39
40	40	40	40	40	40
41	41	41	41	41	41
42	42	42	42	42	42
43	43	43	43	43	43
44	44	44	44	44	44
45	45	45	45	45	45
46	46	46	46	46	46
47	47	47	47	47	47
48	48	48	48	48	48
49	49	49	49	49	49
50	50	50	50	50	50
51	51	51	51	51	51
52	52	52	52	52	52
53	53	53	53	53	53
54	54	54	54	54	54
55	55	55	55	55	55
56	56	56	56	56	56
57	57	57	57	57	57
58	58	58	58	58	58
59	59	59	59	59	59
60	60	60	60	60	60
61	61	61	61	61	61
62	62	62	62	62	62
63	63	63	63	63	63
64	64	64	64	64	64
65	65	65	65	65	65
66	66	66	66	66	66
67	67	67	67	67	67
68	68	68	68	68	68
69	69	69	69	69	69
70	70	70	70	70	70
71	71	71	71	71	71
72	72	72	72	72	72
73	73	73	73	73	73
74	74	74	74	74	74
75					

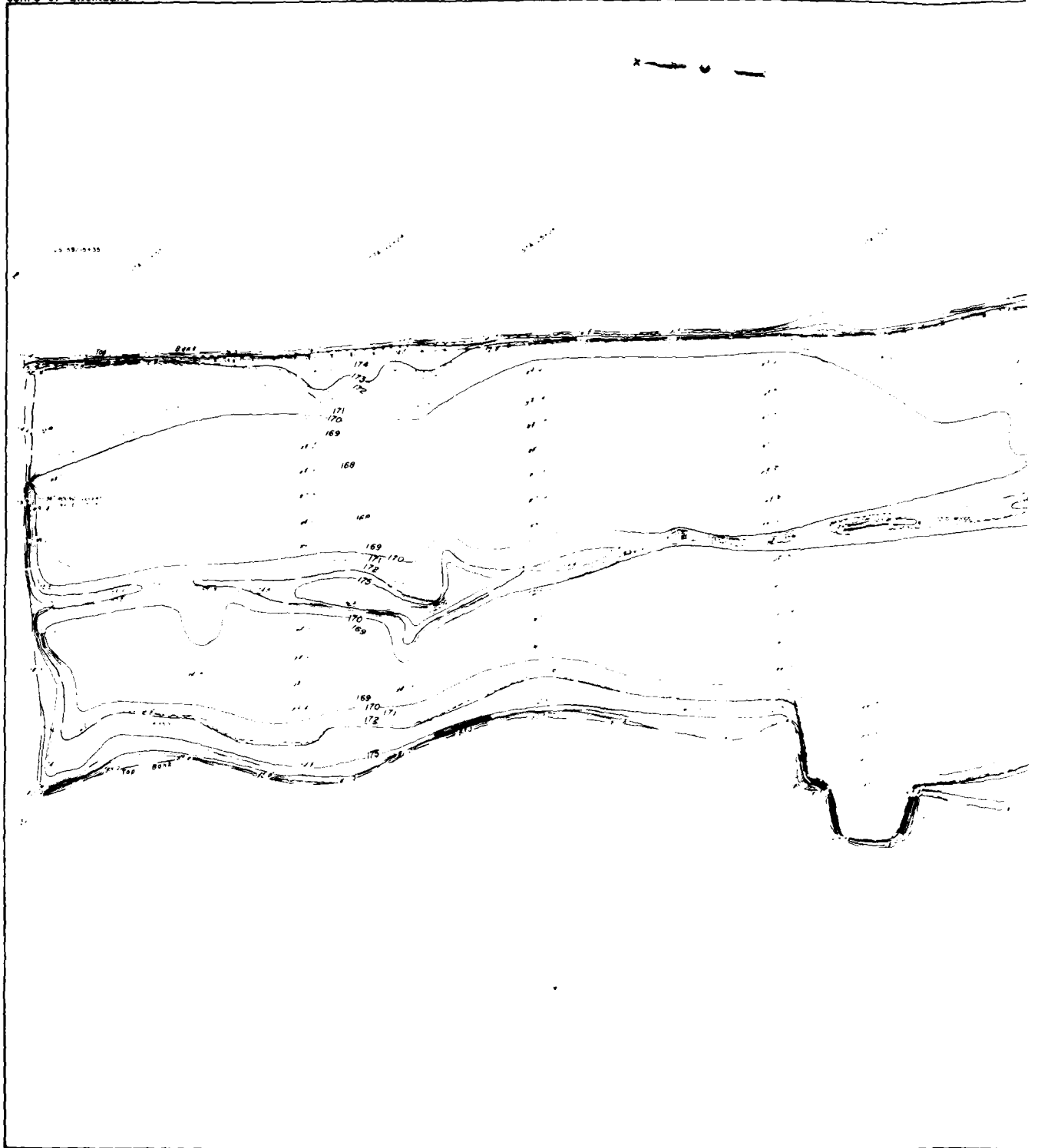
U.S. ARMY ENGINEER DISTRICT, VICKSBURG 1962
CORPS OF ENGINEERS
Prepared under the direction of
Col Samuel P Collins, District Engineer

RELATIONS IN FEET M & D (ON) 048 METERAL F307

SURVEY BY SULLIVAN, ROSTER & BROOKS ON FEB 1962 FILE NO. M & D

P1T NO 14

CORPS OF ENGINEERS





LEGEND
--- CONTROLLING CONTOUR

MISSISSIPPI RIVER BASIN
TAMPA, FLORIDA - MISSISSIPPI

MISSISSIPPI RIVER BORROW PITS

1:50,000

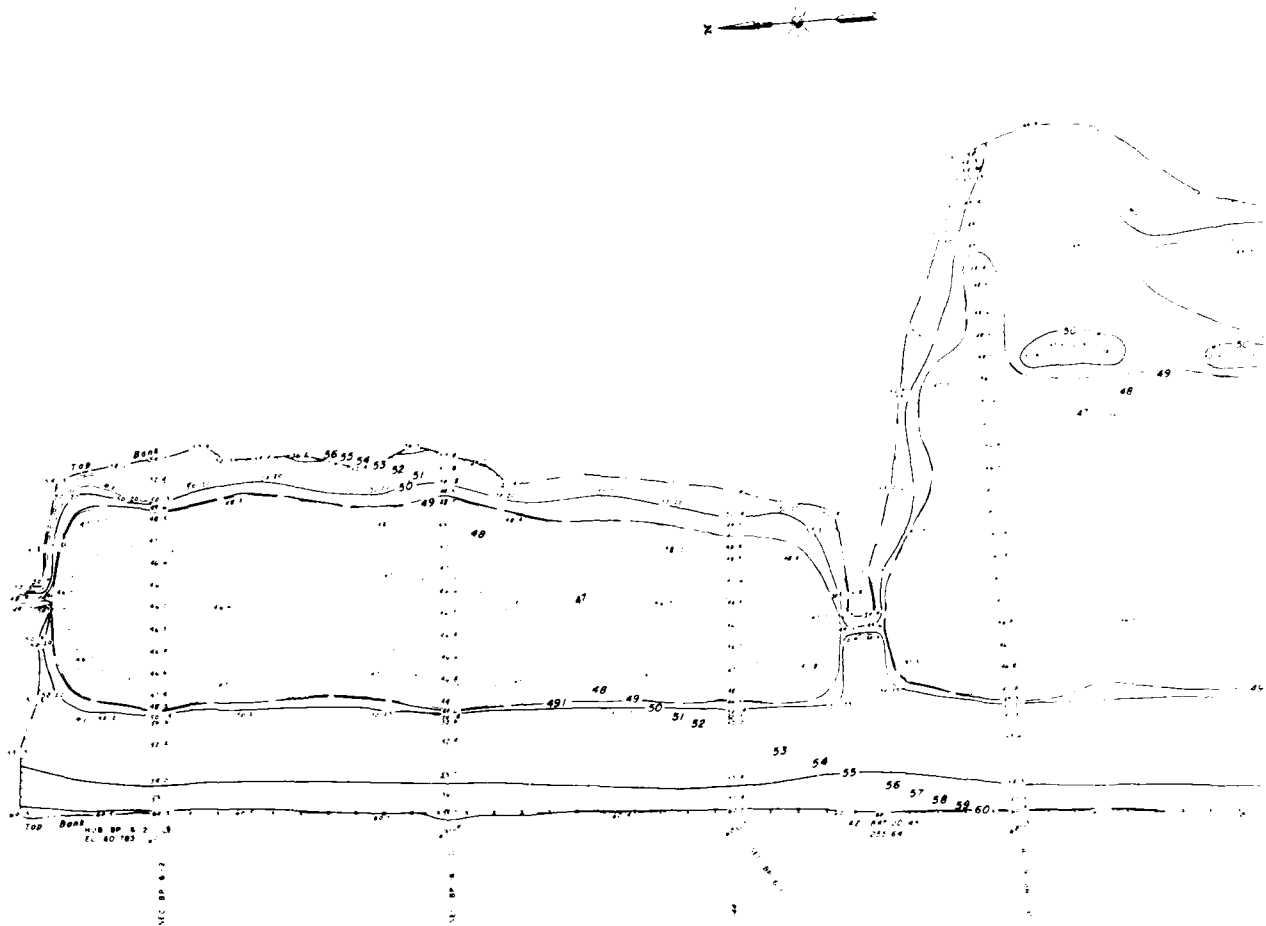
U.S. ARMY ENGINEER DISTRICT VICKSBURG 1987
CORPS OF ENGINEERS
Prepared under the direction of
Cdr. Samuel P. Collins, District Engineer

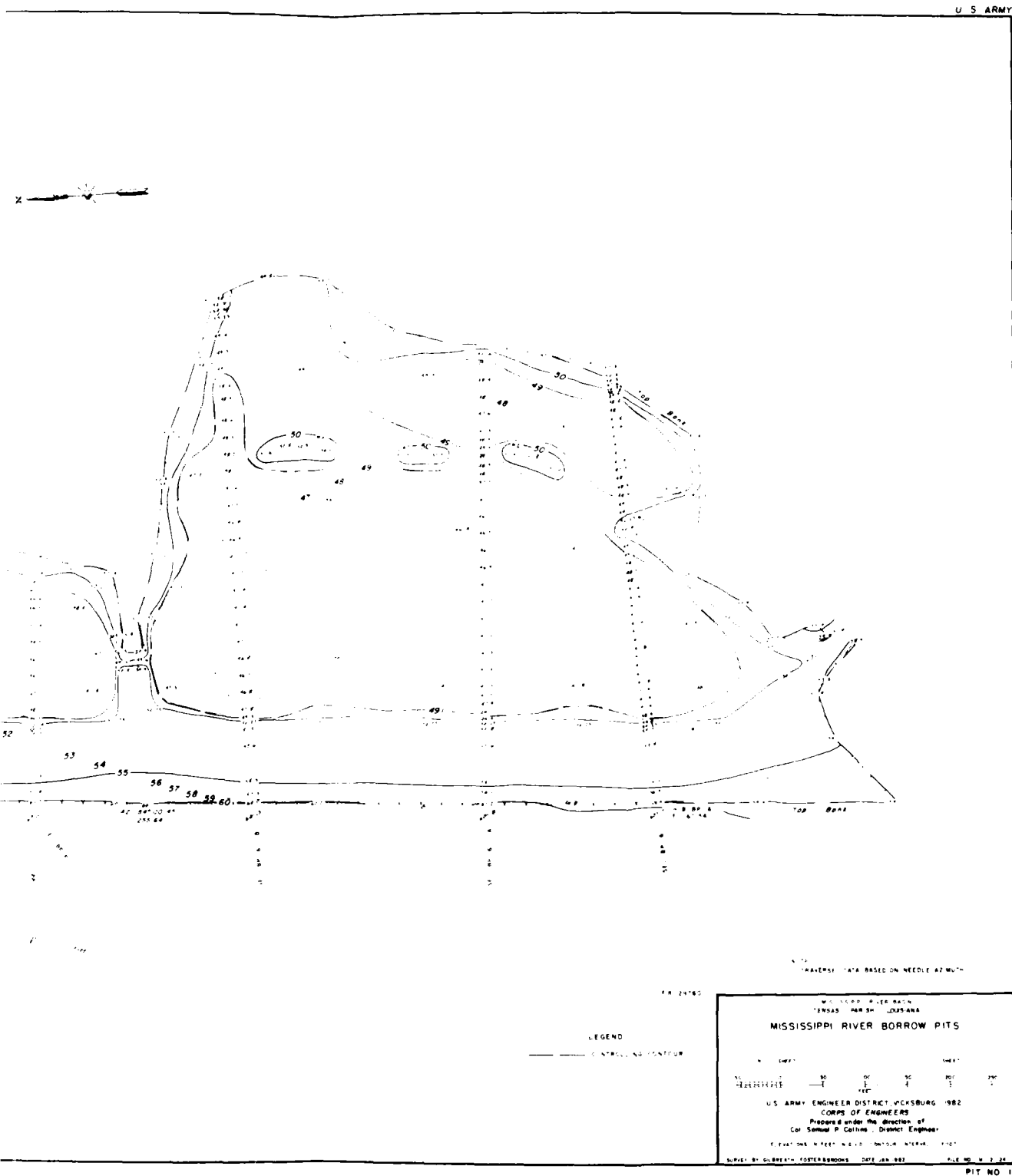
VERTICAL SCALE: 1" = 100'

DATE: FEB 1988

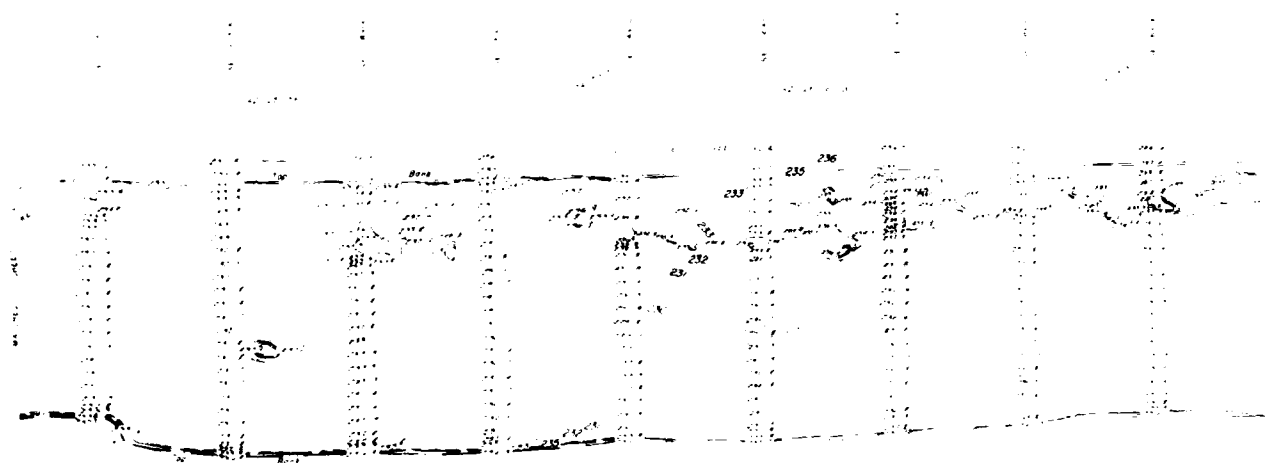
FILE NO. 15

CORPS OF ENGINEERS



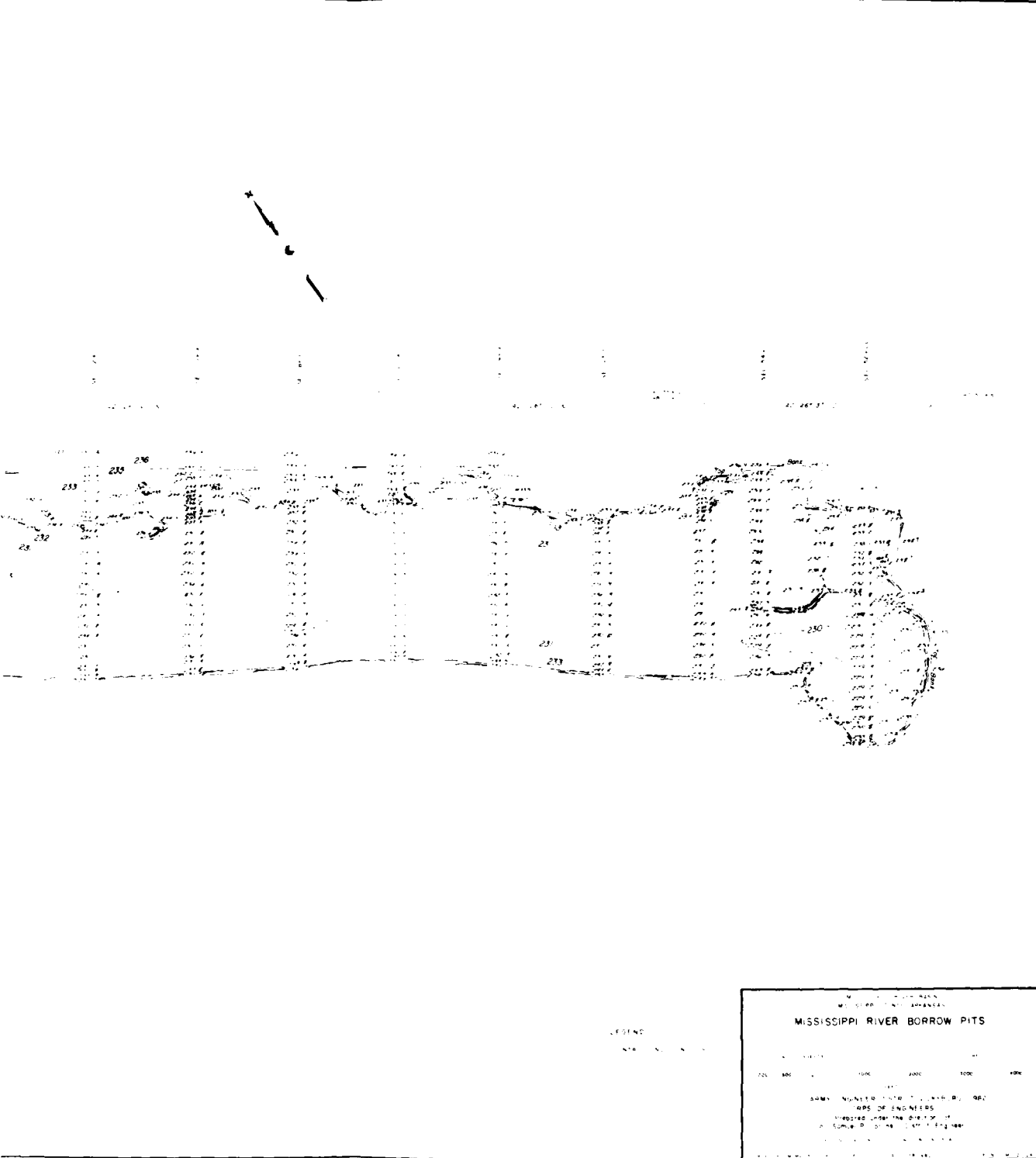


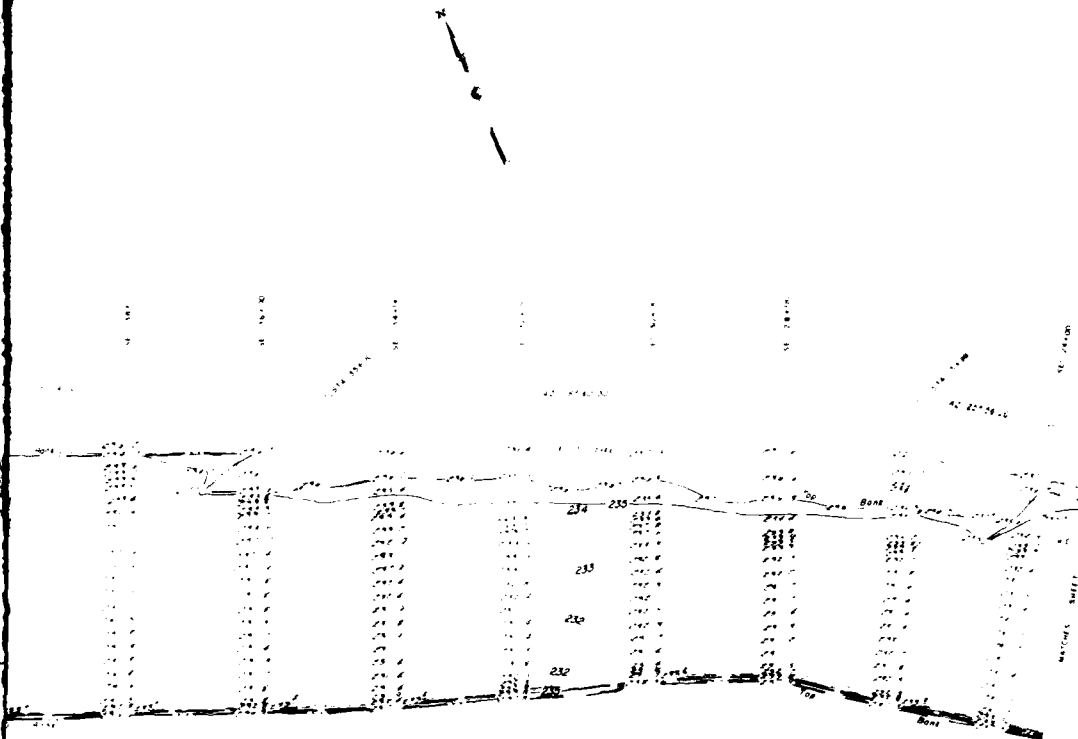
CORPS OF ENGINEERS



1

1





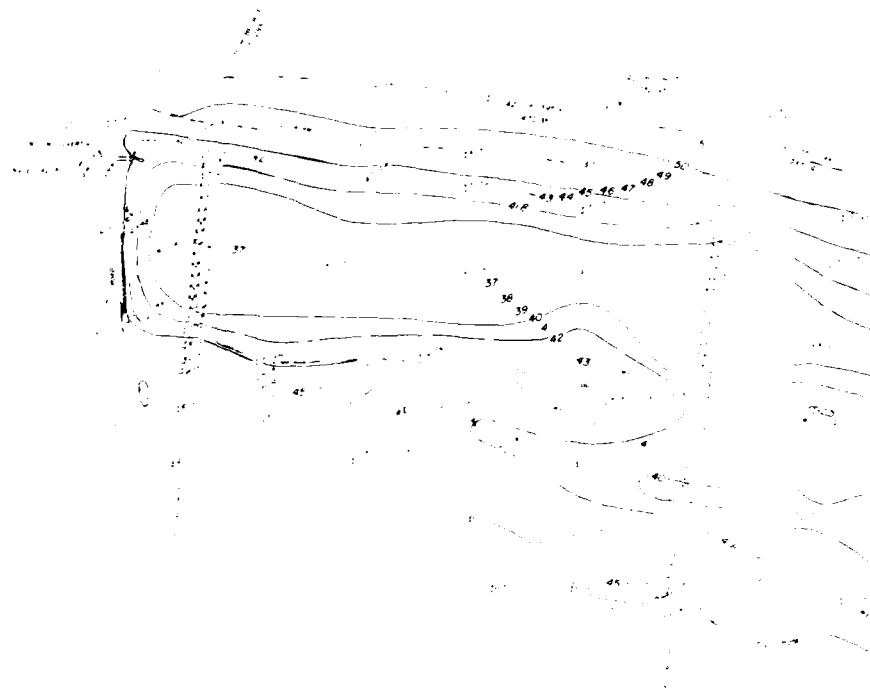
LEGEND
 1/2" = 100' HORIZONTAL
 1" = 10' VERTICAL

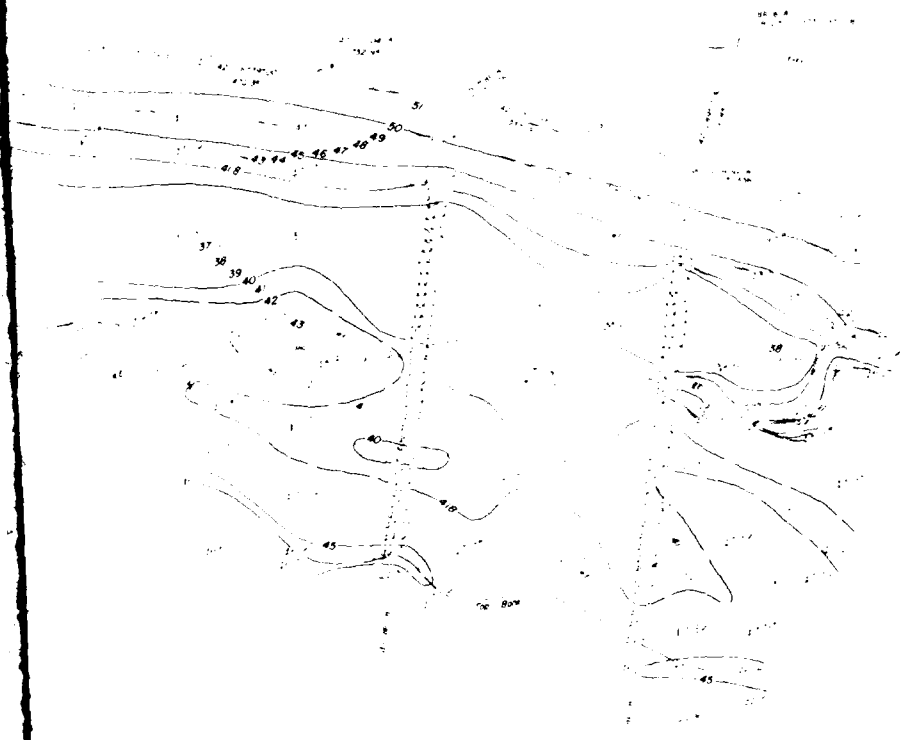
MISSISSIPPI RIVER BORROW PITS
 MISSISSIPPI COUNTY, ARKANSAS

U.S. ARMY ENGINEER DISTRICT VICKSBURG 982
 CORPS OF ENGINEERS
 Prepared by the direction of
 Col. Samuel P. Collins, District Engineer
 U.S. ARMY ENGINEER DISTRICT VICKSBURG 982
 DATE: FEB. 1962

CORPS OF ENGINEERS

— A — Z





LEGEND

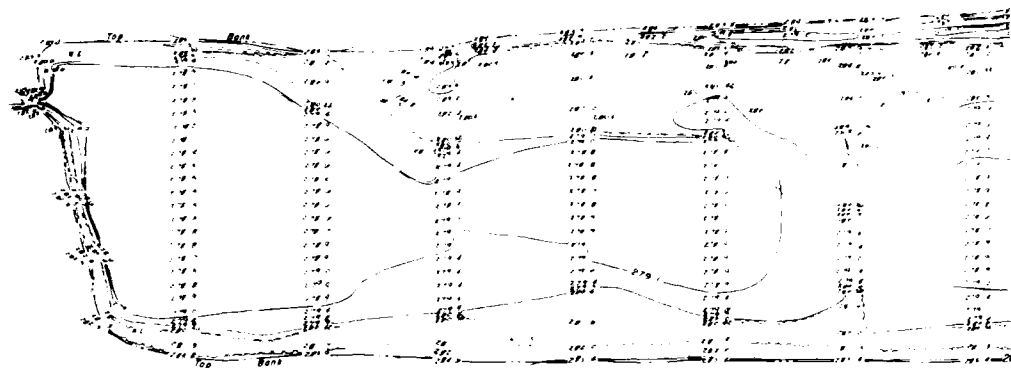
MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT VICKSBURG 1982
CORPS OF ENGINEERS
Prepared under the direction of
L. Dennis J. York, District Engineer

DATE: 10/1/82 BY: [Signature]

PIT NO 18

CORPS OF ENGINEERS

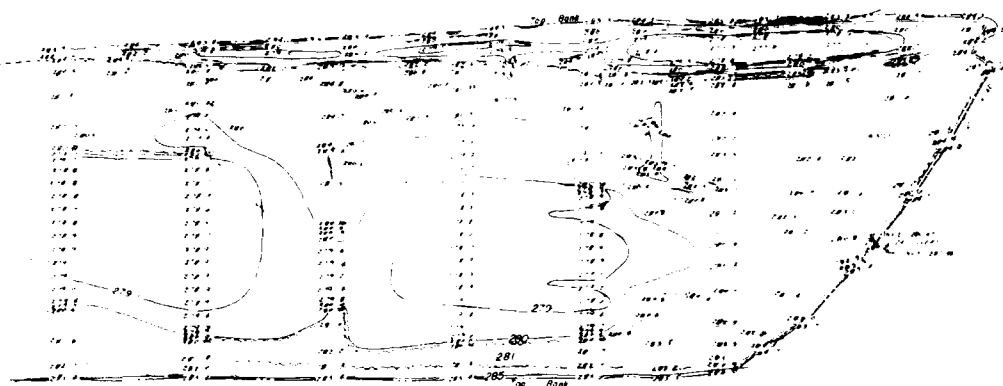


1. 12-84 27

2. 12-84 27

3. 12-84 27

1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10



42 28' 24" N. 42 28' 24" E.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

LEGEND

CONTINUOUS LINE

MISSISSIPPI RIVER BORROW PITS

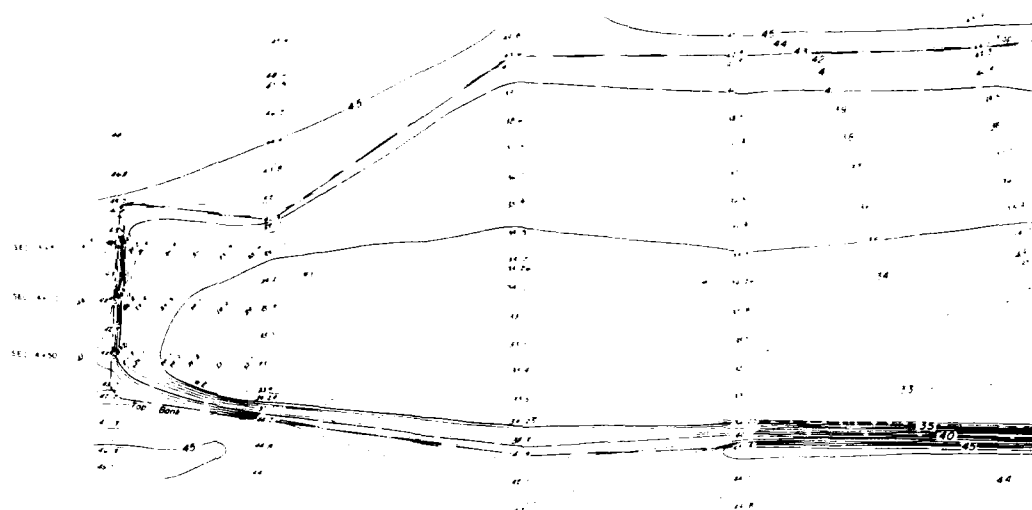


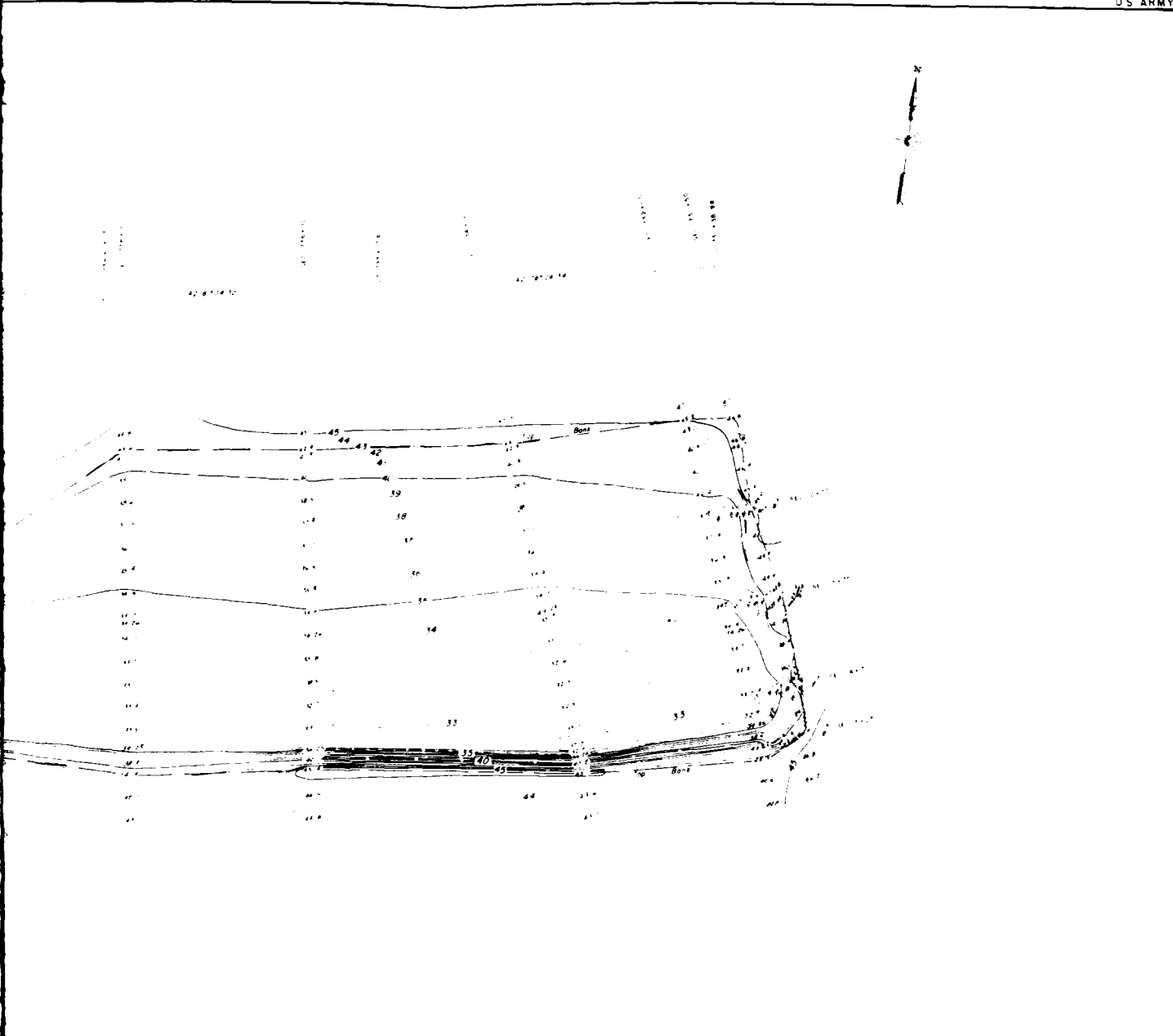
U.S. ARMY ENGINEER DISTRICT, VICKSBURG 982
CORPS OF ENGINEERS
Prepared under the direction of
Major P. Collins, District Engineer

REVISIONS: 1. 10/1/50 2. 10/1/50 3. 10/1/50 4. 10/1/50 5. 10/1/50 6. 10/1/50 7. 10/1/50 8. 10/1/50 9. 10/1/50 10. 10/1/50

SURVEY BY: MISSISSIPPI DISTRICT, VICKSBURG 982 DATE: FEB 1951 FILE NO. 10-1-24

PIT NO. 19



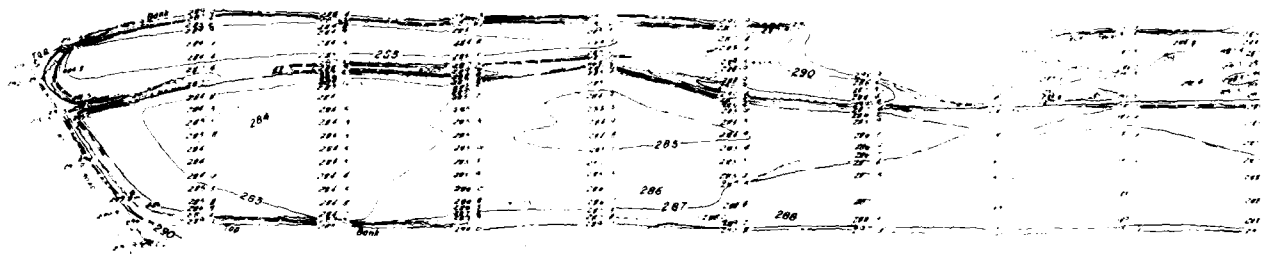


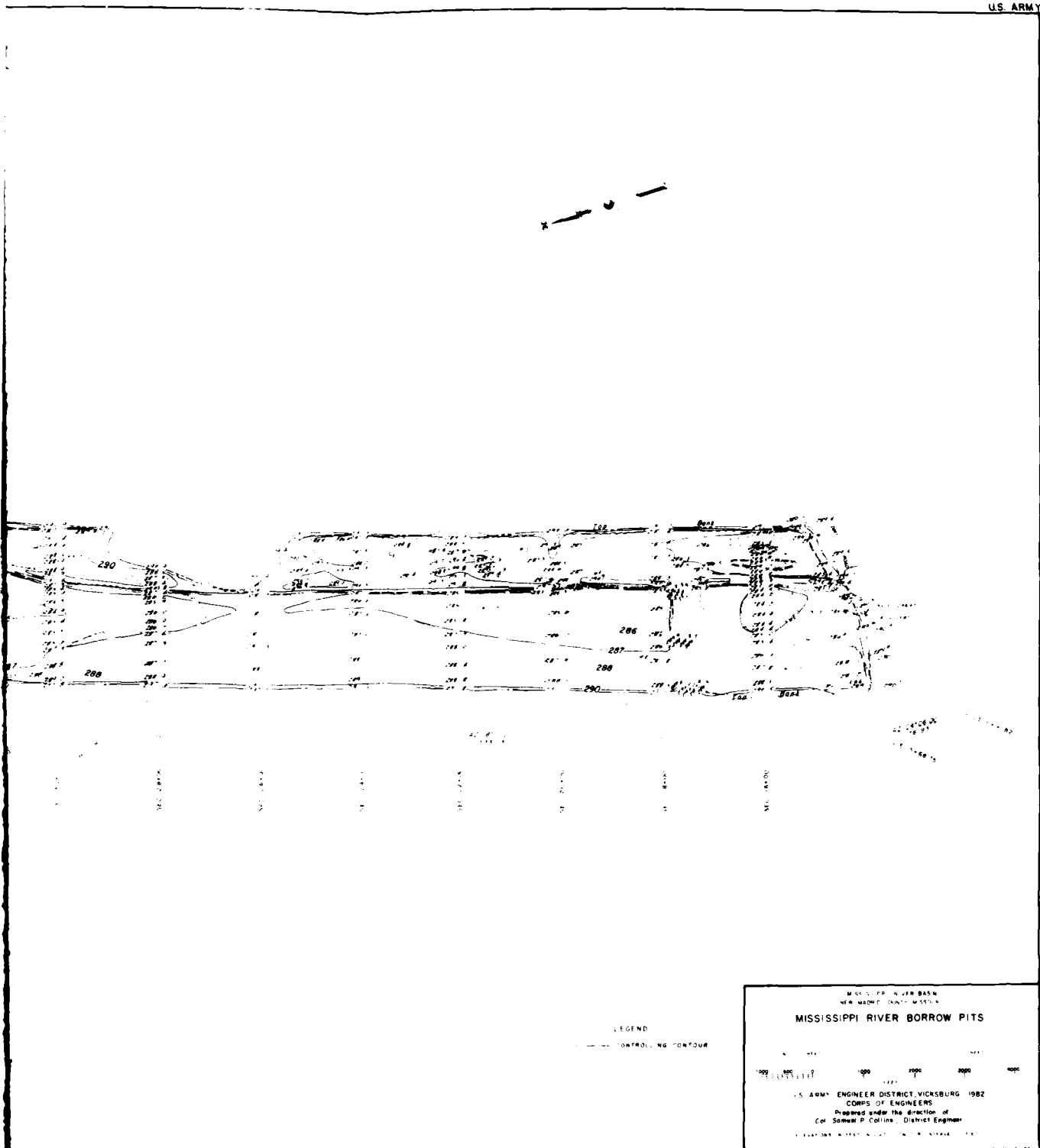
LEGEND

MISSISSIPPI RIVER BORROW PITS

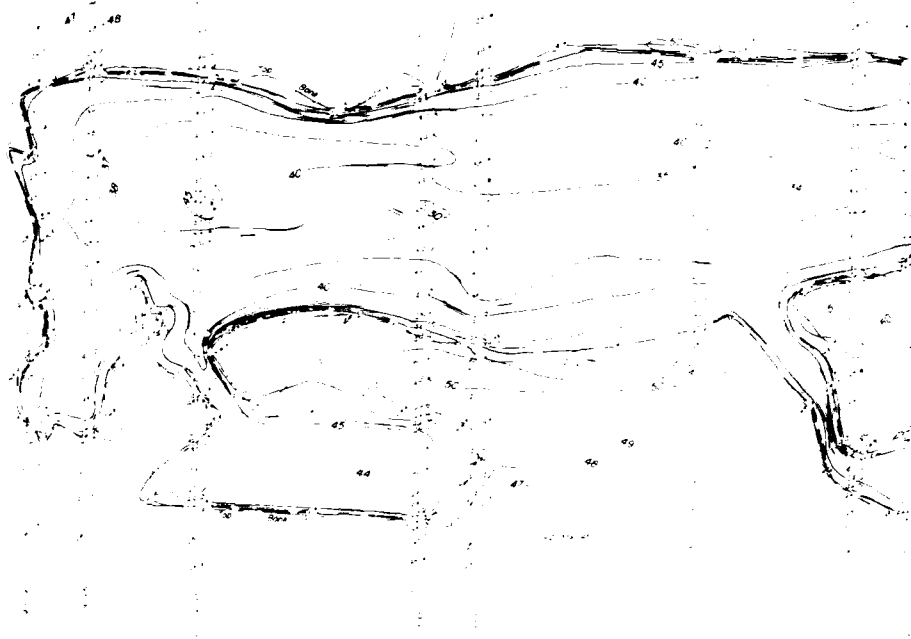
U.S. ARMY ENGINEER DISTRICT, VICKSBURG 1962
 MAPS OF ENGINEERS
 Prepared under the direction of
 Col. Samuel P. Collins, District Engineer
 1:50,000 SCALE (VERTICAL INTERVAL, 100 FT.)

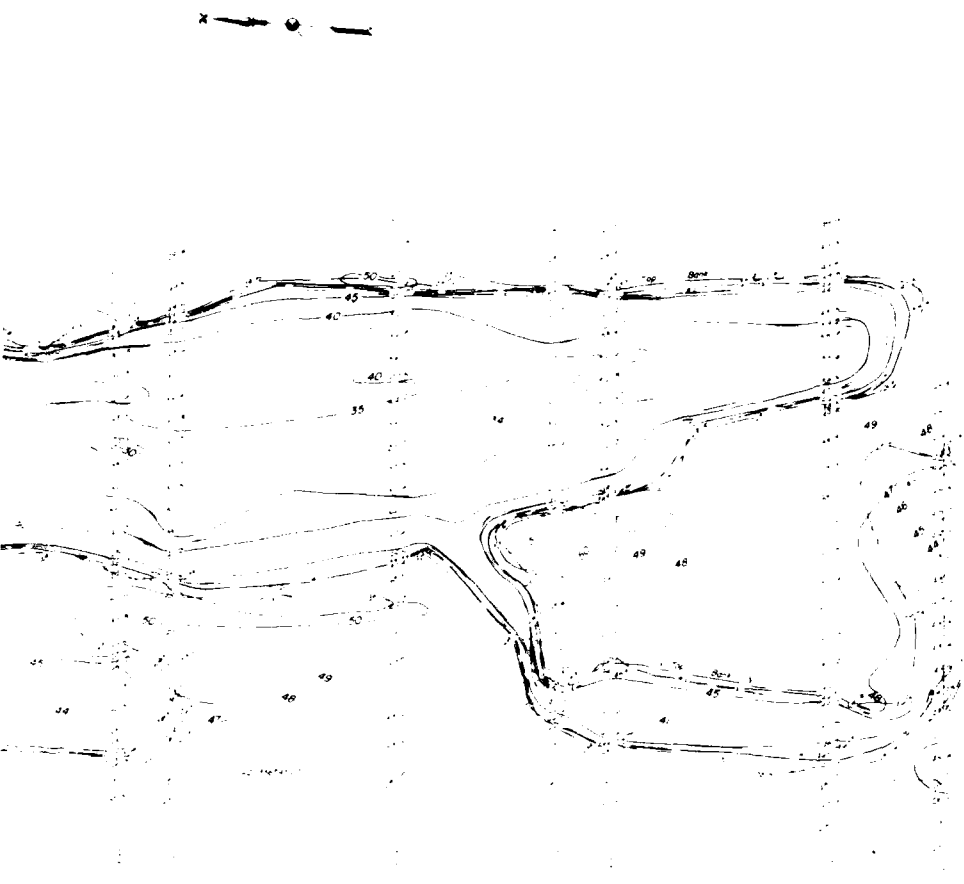
CORPS OF ENGINEERS





CORPS OF ENGINEERS



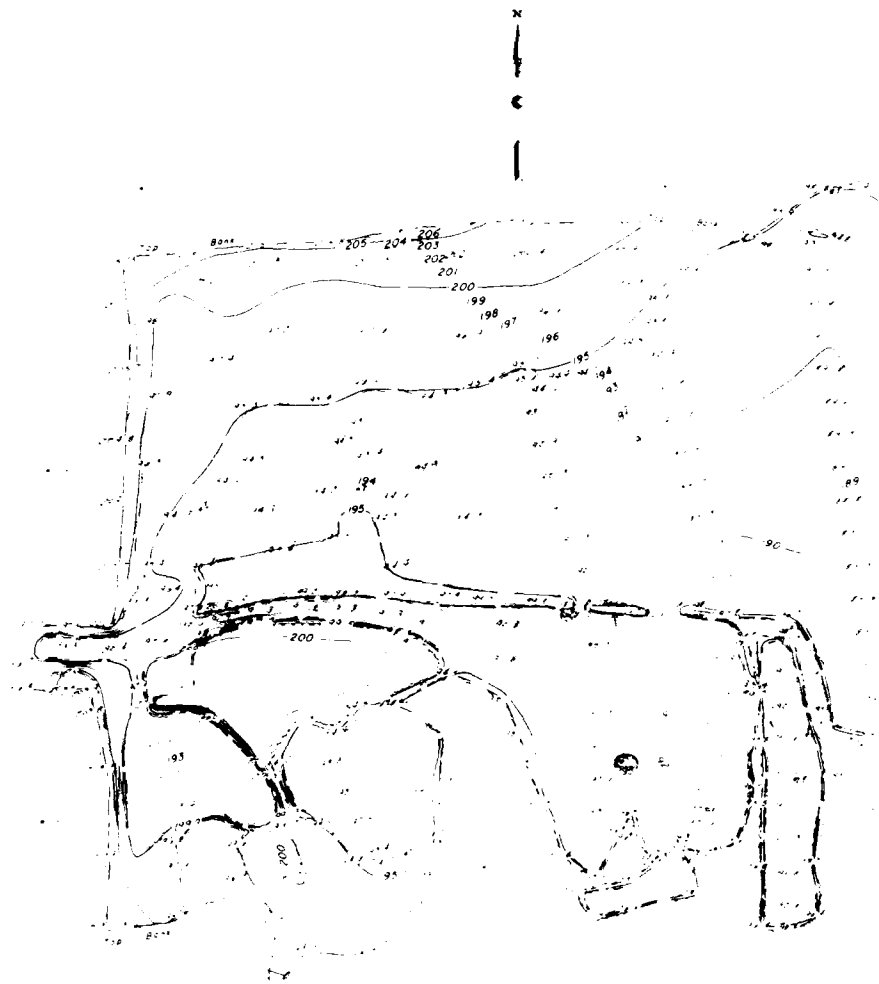


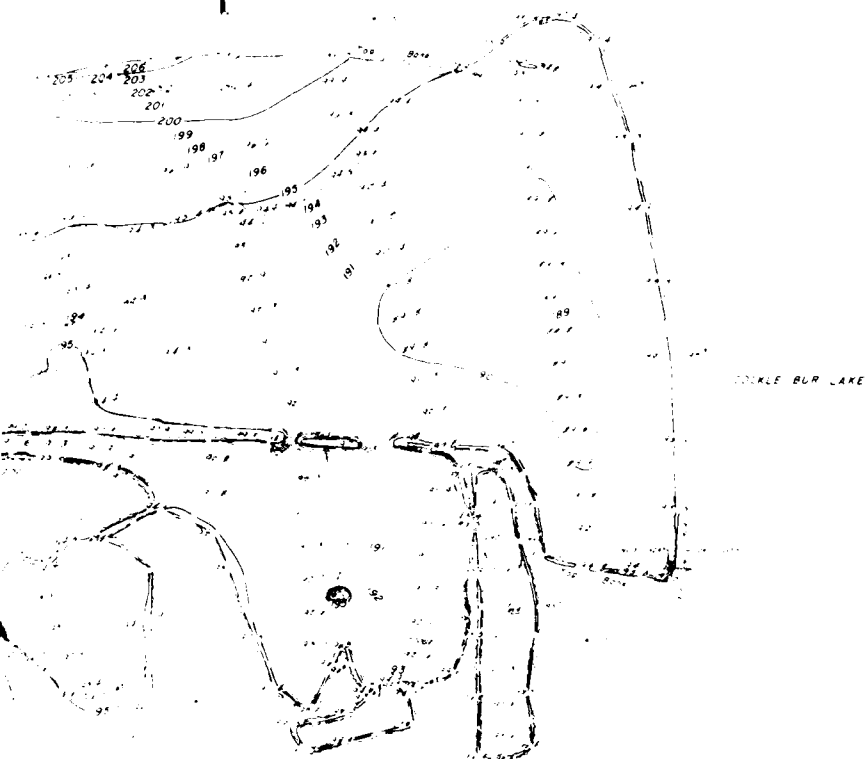
MISSISSIPPI RIVER BORROW PITS

ENGINEER DISTRICT NO. 40 982

Prepared under the direction of
Samuel P. Collins, District Engineer

CORPS OF ENGINEERS

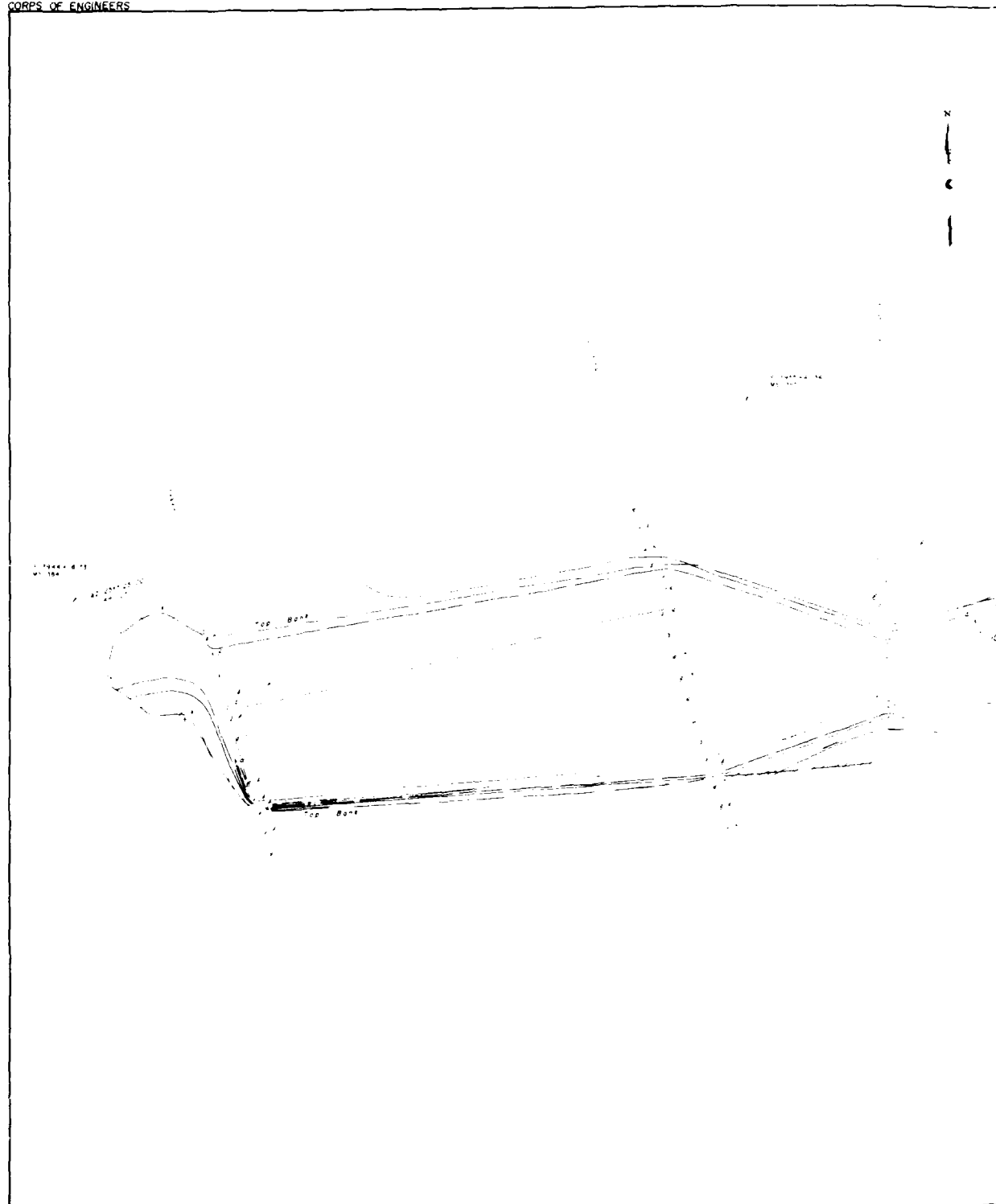




\mathbb{R}^n

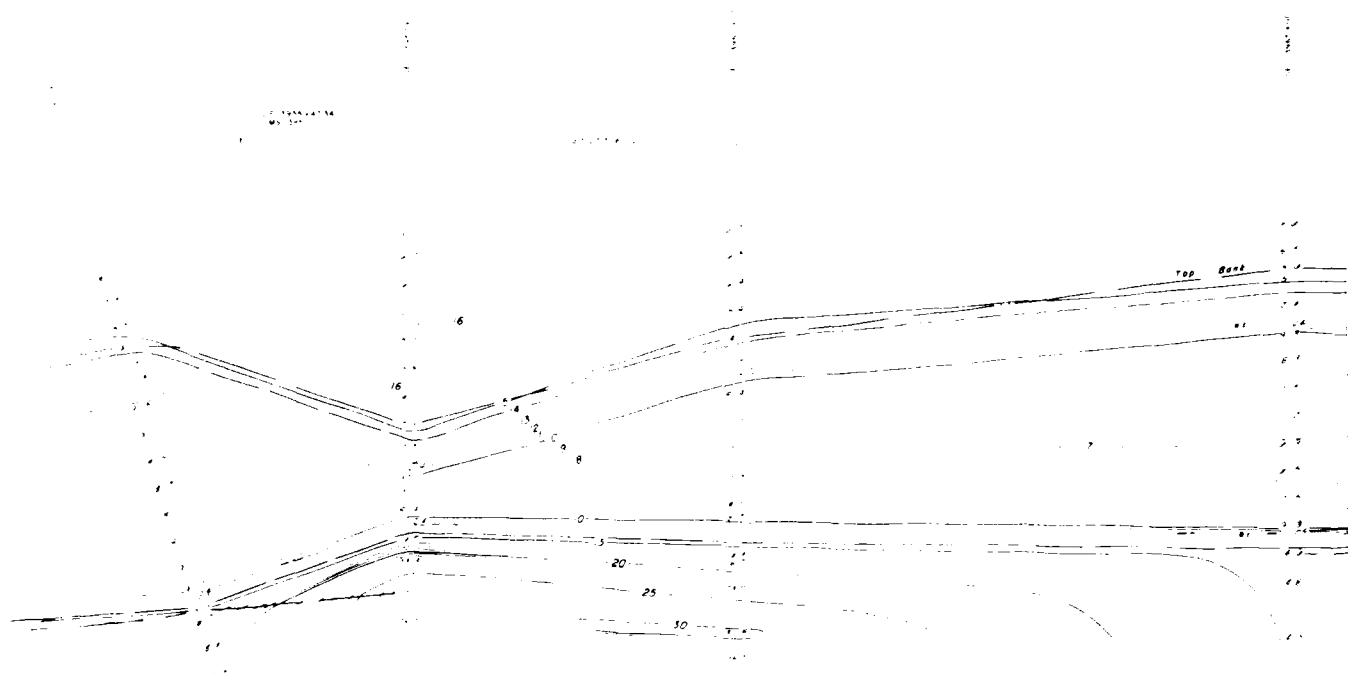
MISSISSIPPI RIVER BORROW PITS

CORPS OF ENGINEERS



1

X
C
I



LEGEND

MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT VICKSBURG 982

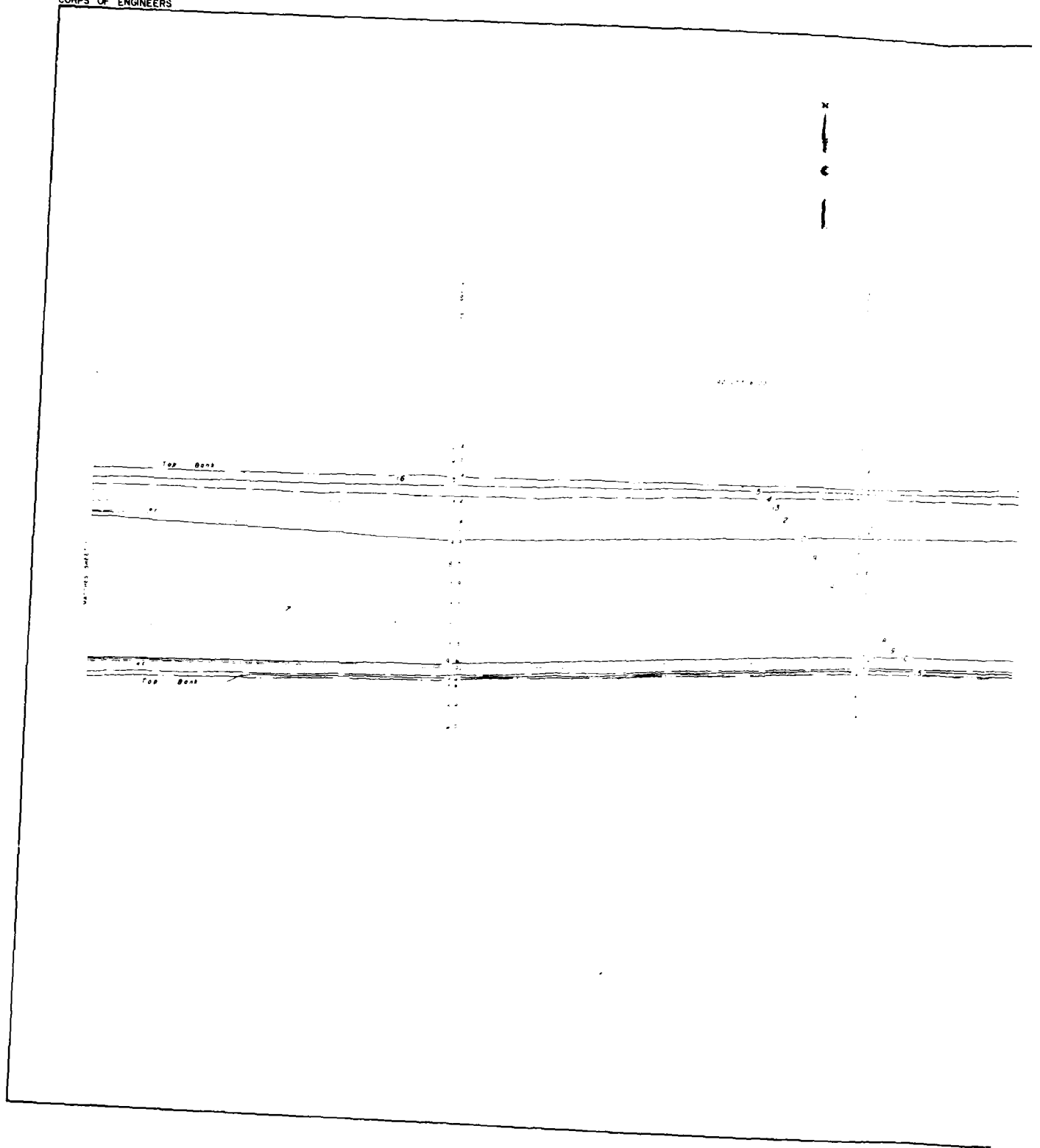
PREPARED UNDER THE DIRECTION OF

Samuel P. Collins, District Engineer

FILED IN NEW ORLEANS 1917

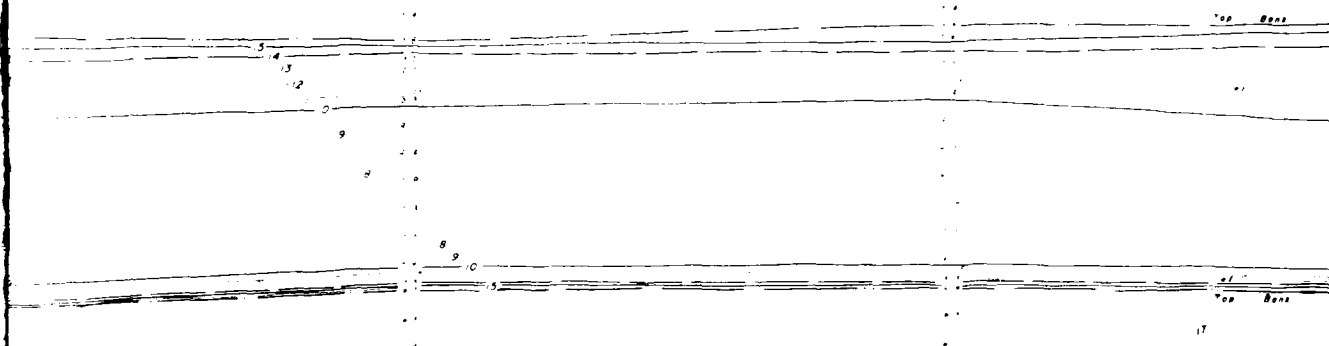
PIT NO 24

CORPS OF ENGINEERS



X
C
I

40 111 8 00



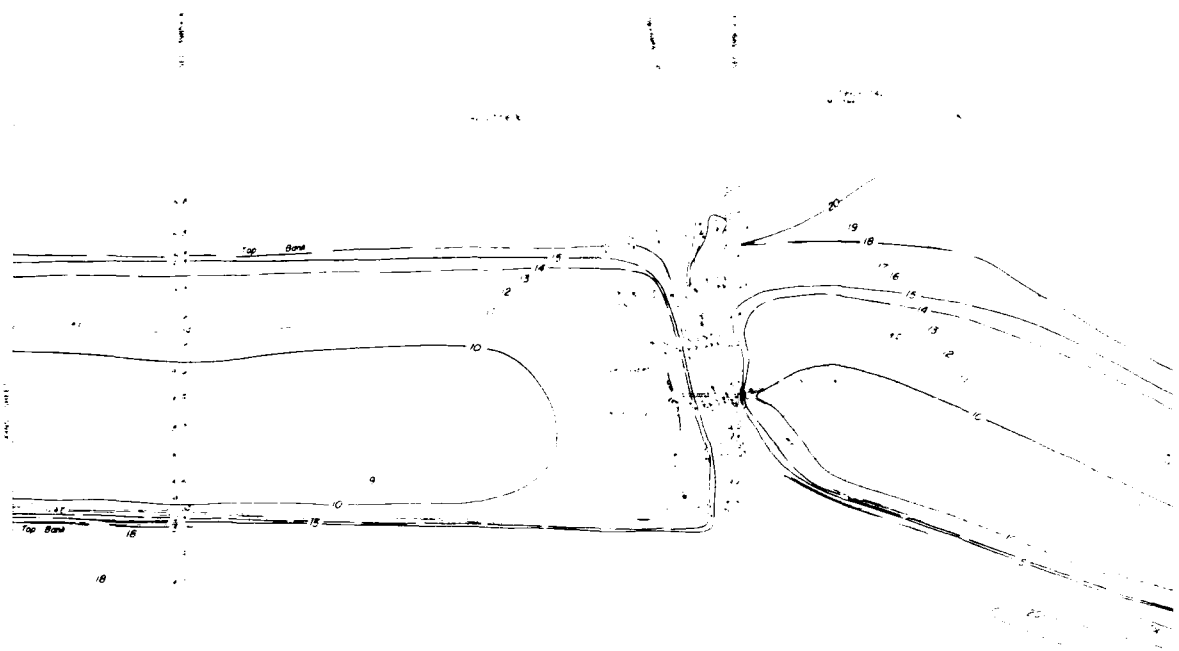
LEGEND

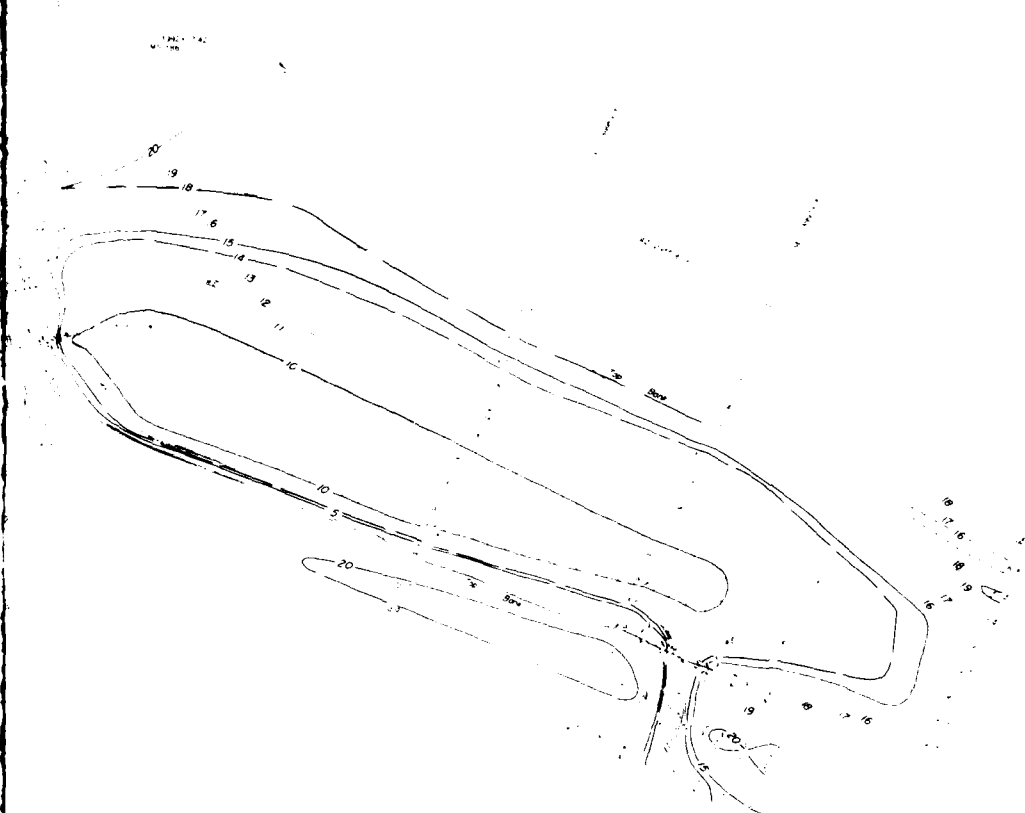
1. CENTER LINE

MISSISSIPPI RIVER BORROW PITS

1. CENTER LINE
2. BORROW PIT
3. BORROW PIT
4. BORROW PIT
5. BORROW PIT
6. BORROW PIT
7. BORROW PIT
8. BORROW PIT
9. BORROW PIT
10. BORROW PIT
11. BORROW PIT
12. BORROW PIT
13. BORROW PIT
14. BORROW PIT
15. BORROW PIT
16. BORROW PIT
17. BORROW PIT
18. BORROW PIT
19. BORROW PIT
20. BORROW PIT
21. BORROW PIT
22. BORROW PIT
23. BORROW PIT
24. BORROW PIT
25. BORROW PIT
26. BORROW PIT
27. BORROW PIT
28. BORROW PIT
29. BORROW PIT
30. BORROW PIT
31. BORROW PIT
32. BORROW PIT
33. BORROW PIT
34. BORROW PIT
35. BORROW PIT
36. BORROW PIT
37. BORROW PIT
38. BORROW PIT
39. BORROW PIT
40. BORROW PIT
41. BORROW PIT
42. BORROW PIT
43. BORROW PIT
44. BORROW PIT
45. BORROW PIT
46. BORROW PIT
47. BORROW PIT
48. BORROW PIT
49. BORROW PIT
50. BORROW PIT
51. BORROW PIT
52. BORROW PIT
53. BORROW PIT
54. BORROW PIT
55. BORROW PIT
56. BORROW PIT
57. BORROW PIT
58. BORROW PIT
59. BORROW PIT
60. BORROW PIT
61. BORROW PIT
62. BORROW PIT
63. BORROW PIT
64. BORROW PIT
65. BORROW PIT
66. BORROW PIT
67. BORROW PIT
68. BORROW PIT
69. BORROW PIT
70. BORROW PIT
71. BORROW PIT
72. BORROW PIT
73. BORROW PIT
74. BORROW PIT
75. BORROW PIT
76. BORROW PIT
77. BORROW PIT
78. BORROW PIT
79. BORROW PIT
80. BORROW PIT
81. BORROW PIT
82. BORROW PIT
83. BORROW PIT
84. BORROW PIT
85. BORROW PIT
86. BORROW PIT
87. BORROW PIT
88. BORROW PIT
89. BORROW PIT
90. BORROW PIT
91. BORROW PIT
92. BORROW PIT
93. BORROW PIT
94. BORROW PIT
95. BORROW PIT
96. BORROW PIT
97. BORROW PIT
98. BORROW PIT
99. BORROW PIT
100. BORROW PIT

PIT NO. 24



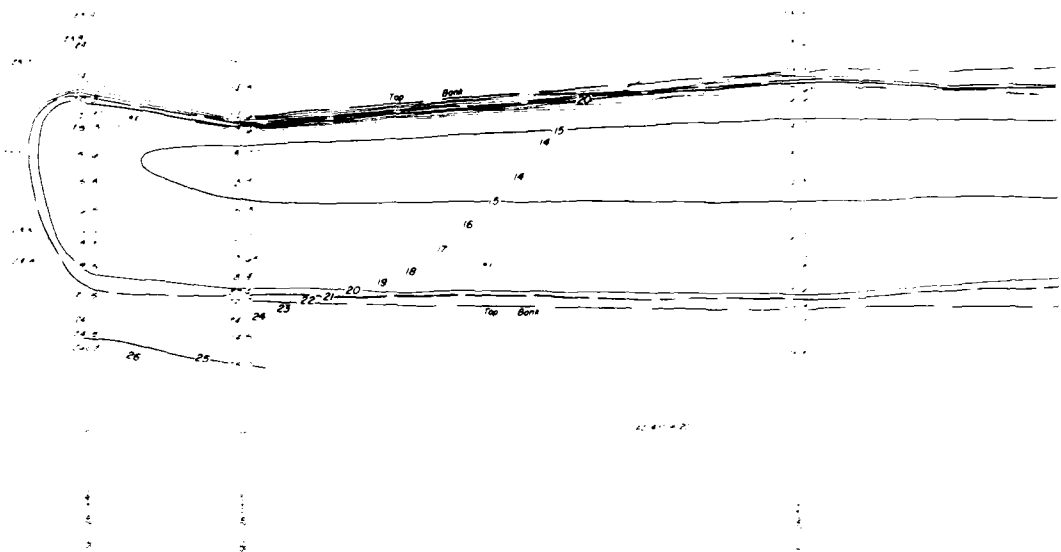


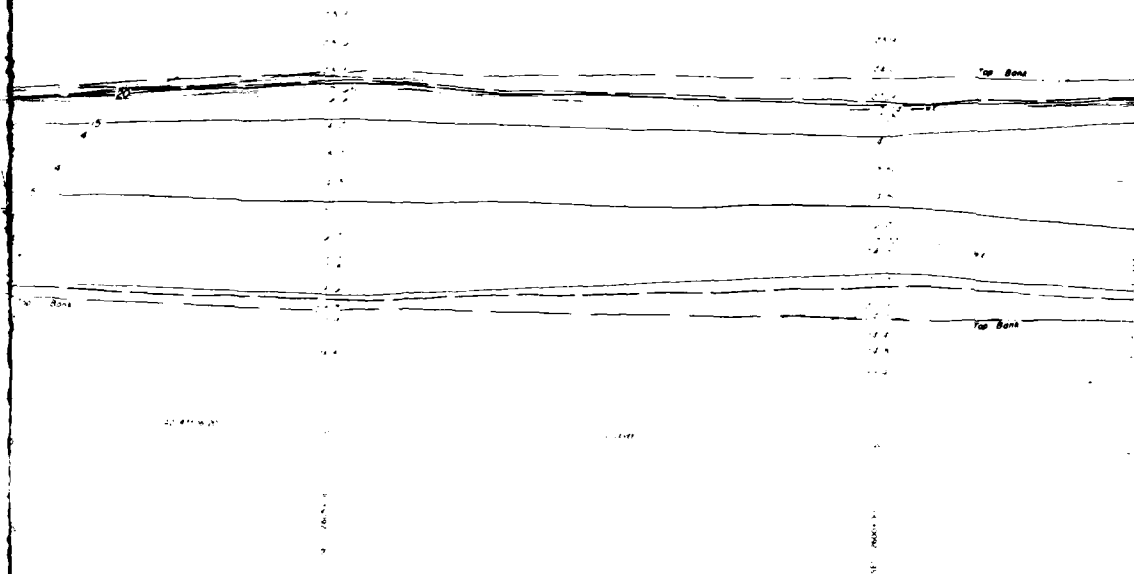
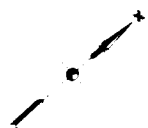
MISSISSIPPI RIVER BASIN
ST. LOUIS DISTRICT
MISSISSIPPI RIVER BORROW PITS

U.S. ARMY ENGINEER DISTRICT VICKSBURG, MISS.
ENGINEERS
Prepared under the direction of
of Samuel H. Jones, District Engineer

U.S. ARMY ENGINEER DISTRICT VICKSBURG, MISS.
PIT NO. 24

CORPS OF ENGINEERS





7. B. 82000
82' 24"

LEGEND

--- CONTROLLING ELEVATION

MISSISSIPPI RIVER BORROW PITS

NO. OF SHEETS					SHEET	
10	20	30	40	50	200	250
1	1	1	1	1	1	1
FEET					FEET	

U.S. ARMY ENGINEER DISTRICT, VICKSBURG 1982

CORPS OF ENGINEERS

Prepared under the direction of

Col Samuel P. Collins, District Engineer

ELEVATIONS IN FEET, M.S.L. CONTOUR INTERVAL 100'

SURVEYED BY: MISSISSIPPI DISTRICT, CIVIL ENGINEER

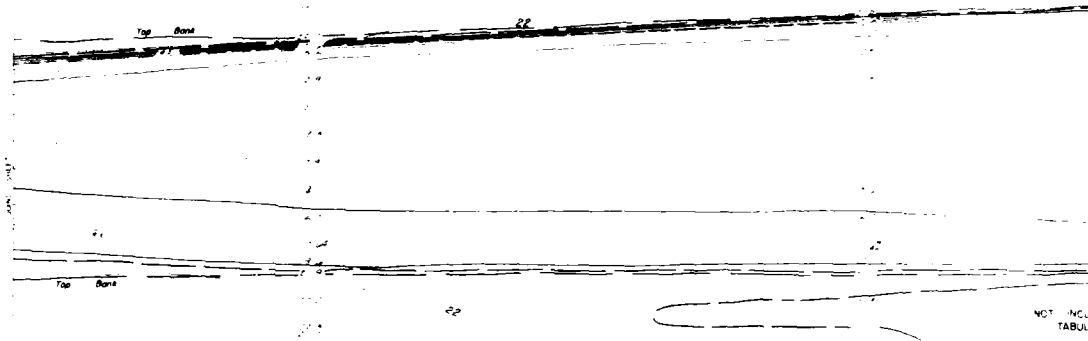
PIT NO 25

1

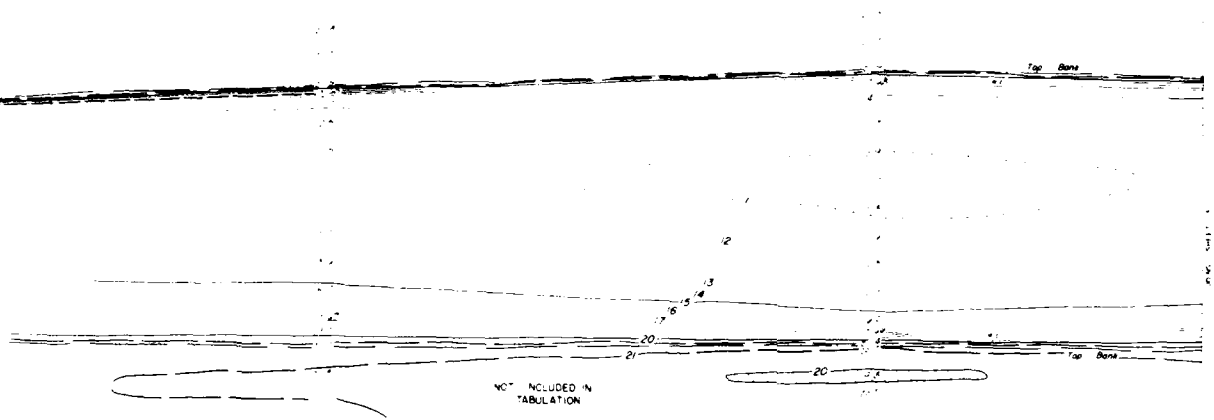
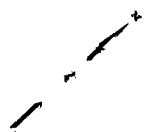
1

2

CORPS OF ENGINEERS



NOT INCL.
TABUL.



LEGEND

1. CENTERLINE

MISSISSIPPI RIVER BORROW PITS

1. CENTERLINE
2. BORROW PIT
3. BORROW PIT
4. BORROW PIT
5. BORROW PIT
6. BORROW PIT
7. BORROW PIT
8. BORROW PIT
9. BORROW PIT
10. BORROW PIT
11. BORROW PIT
12. BORROW PIT
13. BORROW PIT
14. BORROW PIT
15. BORROW PIT
16. BORROW PIT
17. BORROW PIT
18. BORROW PIT
19. BORROW PIT
20. BORROW PIT
21. BORROW PIT

U.S. ARMY ENGINEER DISTRICT, Vicksburg, 1980

Prepared under the direction of

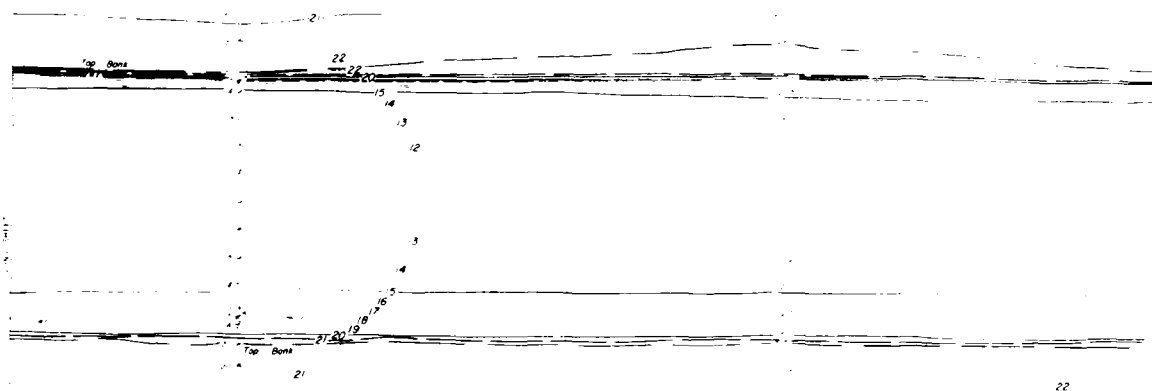
Col. Samuel P. Collins, District Engineer

1. CENTERLINE
2. BORROW PIT
3. BORROW PIT
4. BORROW PIT
5. BORROW PIT
6. BORROW PIT
7. BORROW PIT
8. BORROW PIT
9. BORROW PIT
10. BORROW PIT
11. BORROW PIT
12. BORROW PIT
13. BORROW PIT
14. BORROW PIT
15. BORROW PIT
16. BORROW PIT
17. BORROW PIT
18. BORROW PIT
19. BORROW PIT
20. BORROW PIT
21. BORROW PIT

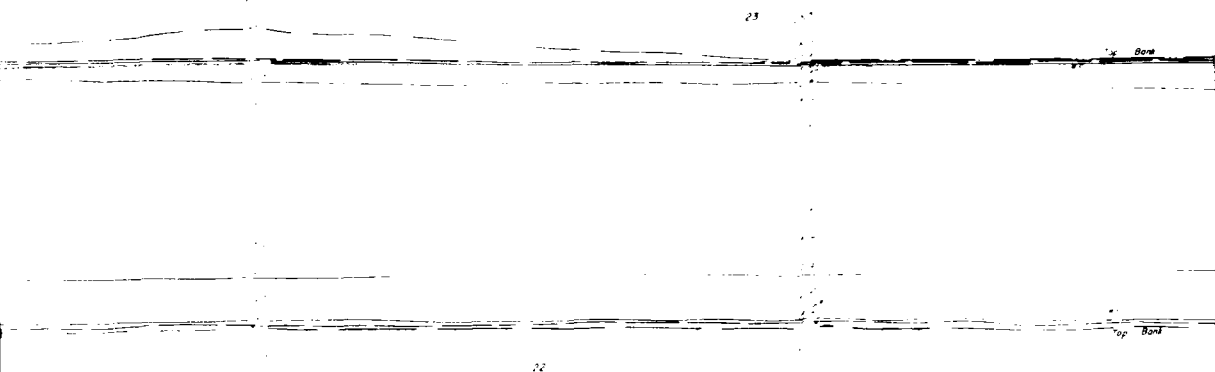
MISSISSIPPI RIVER BORROW PITS, Vicksburg, 1980

PIT NO. 25

CORPS OF ENGINEERS



1

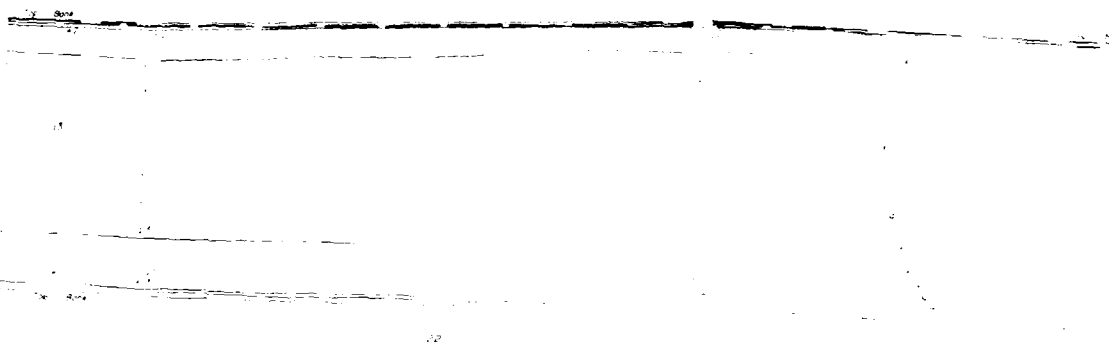


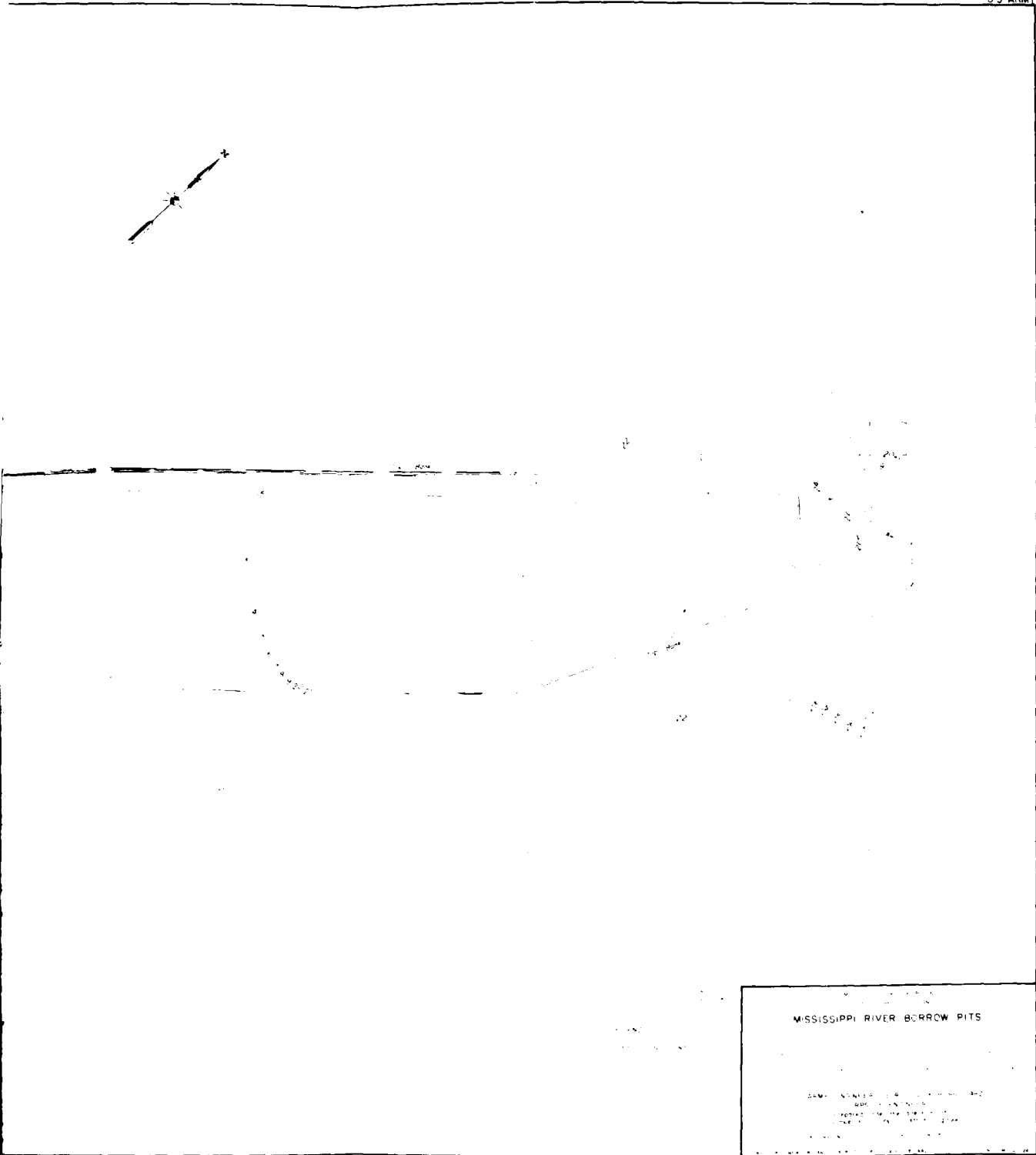
LEGEND

NOT TO SCALE

<p>MISSISSIPPI RIVER BORROW PITS</p> <p>U.S. ARMY ENGINEER DISTRICT OF KANSAS CITY 482</p> <p>Prepared under the direction of</p> <p>Colonel R. P. Jones, District Engineer</p> <p>Approved by District Engineer, Kansas City 482</p> <p>U.S. ARMY ENGINEER DISTRICT OF KANSAS CITY 482</p>	
---	--

CORPS OF ENGINEERS





CORPS OF ENGINEERS



